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THERMAL LOADING IN THE MARINE DISTRICT¹

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ABSTRACT

Increased development of steam electric stations in New York's Marine District is resulting in considerable thermal loading of the marine waters. The Marine District includes part of the lower Hudson River, the New York side of Long Island Sound and the Atlantic Ocean out to the 3-mile limit. Fossil- and nuclear-fuel plants use the Hudson for coolant water, and more nuclear plants are planned for the river. Three fossil-fuel plants are operating on Long Island Sound and two nuclear-fuel plants are planned. Two fossil-fuel plants are operating on the south shore of Long Island. Potential thermal discharge into the lower Hudson River is 3.0 billion gallons per day. Potential discharge on New York's side of Long Island Sound is 8.2 billion gallons per day. Temperature increase above ambient is between 20° and 30° F. The Hudson River and Long Island Sound support important commercial and recreational fisheries. Thus, the possibility of ecological damage is a serious consideration.

New York State's Marine District is in the peculiar position of encompassing some of the most densely populated and rapidly growing areas in the Northeast and also some of the most productive marine waters and estuaries in the region. The Marine District includes the waters of the Atlantic Ocean within 3 nautical miles from the coast and all other tidal waters within the State including the Hudson River up to the Tappan Zee Bridge (Figure 1). Thus, the waters of the district border parts of Rockland and Westchester Counties, all of New York City, and Nassau and Suffolk Counties (Long Island). More than 10 million people live in this area and it is the site of many businesses and industries.

In 1968, the commercial fisheries within the Marine District landed 44.9 million pounds of finfish worth \$2.9 million (ex-vessel) and 14.4 million pounds of shellfish worth \$11.4 million. There also is a flourishing recreational fishery for a variety of marine species, the volume and value of which are not easy to assess. However, it has been estimated that 1 million anglers fish in the waters of New York's Marine District and contribute more than \$10 million to the local economy (Wallace and Jensen, 1967).

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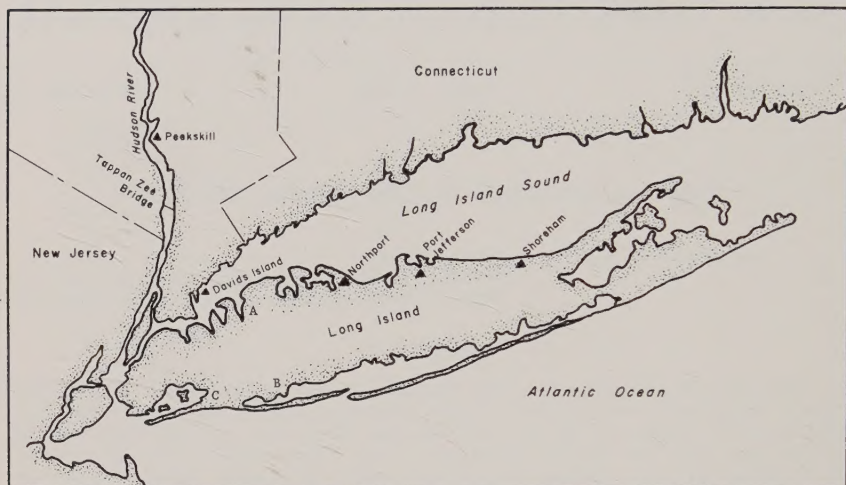


Figure 1. Location of operating and proposed steam electric stations that affect New York's Marine District. Long Island plants not named on the chart are: (A) Glenwood Landing, (B) Barrett Plant and (C) Far Rockaway.

The dense population and number of industrial complexes within the Marine District have created a great demand for electrical power. (In recent years, some parts of New York City have experienced power failures in the summer because of excess demands from air conditioners.) To meet the needs of the public, the electrical generating industry has responded with plans for and construction of more and larger generating facilities. Most of the facilities are fossil-fueled; a few are nuclear-fueled.

It is the purpose of this paper to describe briefly some of the sources of thermal loading in New York's Marine District, the ecology of the areas of discharge and the possible impact of the discharge on the biota of the areas involved.

SOURCES OF WARM-WATER DISCHARGE AND THE ECOLOGICAL IMPLICATIONS

Steam electric plants have been operating in and around New York City almost from the time that steam turbines for generating electricity were introduced in the United States in 1903. Most of them, however, are operating on waters (such as the East River) that were already grossly polluted from sewage and industrial wastes. Thus, there is little natural environment left for the heated discharge to act upon. The maximum output of the stations, 8 million kilowatts (kw) (Table 1), indicates a total discharge from all stations on the order of 4 million gallons per minute (gpm) of heated water. In addition,

TABLE 1. STEAM ELECTRIC POWER STATIONS OF THE CONSOLIDATED EDISON SYSTEM IN THE VICINITY OF NEW YORK CITY*

Plant	Maximum output (megawatts)	Receiving water
Arthur Kill	878	Arthur Kill
Astoria	1,606	East River
East River	806	East River
Hell Gate	631	East River
Hudson Avenue	860	East River
Kent Avenue	126	East River
Ravenswood	1,845	East River
Sherman Creek	203	Harlem River
Waterside	640	East River
59th Street	214	Hudson River
74th Street	201	East River
Total	8,010	

* Data furnished by the environmental engineer of the Consolidated Edison Company.

there is heated discharge from sugar refineries and other industries on the various receiving waters. Most of the heated water passes out through The Narrows into New York Bight and mixes with the waters of the Atlantic Ocean. Some of the heated discharge, however, passes through the East River into the western end of Long Island Sound. Here it becomes part of the thermal pollution of the sound. The waters of the East River, the Harlem River and the lower Hudson River are relatively non-productive because of the loss of natural edge and the load of contaminants they carry. In the Hudson River above New York City, however, and in Long Island Sound, the biota is productive and is susceptible to possible damage from thermal discharge.

HUDSON RIVER

The Hudson River is the main stream of a massive river system that discharges 21,000 cubic feet per second of fresh water past the lower end of Manhattan (U. S. Department of Health, Education and Welfare, 1965). Tidal influence extends to the Federal dam at Troy approximately 150 miles upstream. Salt water intrusion extends to West Point during normal flow and above Newburgh under extreme low-flow conditions. The part of the Hudson River below the Tappan Zee Bridge has a complicated hydrologic pattern, the extremes of which were noted by Panuzio (1967) who observed that, 2 hours after low water at the Battery, "the Hudson River is ebbing at the surface and receiving flood discharge from Upper New York Bay at the bottom".

Water quality in the tidal part of the Hudson River is low. The HEW report previously cited states, "The entire Hudson River, from the Albany-Troy-Rensselaer [sic] area to the Narrows, can be categorically described as polluted." The pollutants include municipal sewage (raw, and treated to some extent), oil, industrial wastes and heated water from steam electric plants. The latter includes 233 million gallons per day from a nuclear-fuel plant and 165 million gallons per day from a fossil-fuel plant at Indian Point (near Peekskill), both operated by Consolidated Edison of New York (Mt. Pleasant, 1967).

Other utilities also have power plants on the Hudson River, or plans to construct plants, thus serving to add to the thermal load of the river. The Lovett Plant of the Orange and Rockland Utilities, Inc. is located near Tomkins Cove on the west side of the river almost directly opposite the Indian Point plants. This is a fossil-fuel plant with a maximum generating capacity of about 450,000 kw, a thermal discharge of about 200,000 gpm and a water temperature rise of 11° to 19° F. above ambient. A nuclear-fuel plant is planned for Bowline Point, about 5 miles below the Lovett Plant. This plant is designed for a maximum generating capacity of 620,000 kw and would require 380,000 gpm of coolant water from the river. The water returned to the river would be heated about 15° to 25° F. above ambient.

This paper does not deal with sources of thermal pollution on the Hudson River north of Peekskill although there is no doubt they have an effect on the total ecology of the river. The sources listed here are of direct interest to the Marine District because they discharge into areas of the river that are spawning and nursery grounds for a number of species important to marine fisheries. Although these plants are north of the Tappan Zee Bridge and thus technically outside of the Marine District, they are included for this reason.

Studies on the ecology of the Hudson River are reported in the several papers gathered in the volume, "Hudson River Ecology", published in 1967 by the Hudson River Valley Commission of New York. In addition, there have been some very specific studies reported by Rathjen and Miller (1957), Schaefer (1968) and Clark (1968).

The Hudson River supports a diversified fish fauna, and many of the species are taken by both commercial and recreational fishermen. Eighteen species were listed by Perlmutter *et al.* (1967) as most common in a sampling program along the river shore in the area about 20 miles above and below Peekskill (Table 2). The white perch (*Roccus americanus*) is important in the recreational fishery and also contributes to the commercial catch. The striped bass (*Morone sax-*

TABLE 2. EIGHTEEN COMMON SPECIES OF FISH COLLECTED IN THE LOWER HUDSON RIVER BY PERLMUTTER *et al.* (1967)

Common name	Scientific name
Blueback herring	<i>Alosa aestivalis</i>
Alewife	<i>A. pseudoharengus</i>
American shad	<i>A. sapidissima</i>
Bay anchovy	<i>Anchoa mitchilli</i>
Goldfish	<i>Carassius auratus</i>
Carp	<i>Cyprinus carpio</i>
Spottail shiner	<i>Notropis hudsonius</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
American eel	<i>Anguilla rostrata</i>
Banded killifish	<i>Fundulus diaphanus</i>
Mummichog	<i>F. heteroclitus</i>
White perch	<i>Roccus americanus</i>
Striped bass	<i>Morone saxatilis</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Johnny darter	<i>Etheostoma nigrum</i>
White mullet	<i>Mugil curema</i>
Tidewater silverside	<i>Menidia beryllina</i>
Atlantic silverside	<i>M. menidia</i>

atilis) is very important to both the recreational and commercial fisheries. Shad (*Alosa sapidissima*) is the leading commercial species, followed by striped bass and two other species of *Alosa*. In addition, two species of sturgeon, the Atlantic sturgeon (*Acipenser oxyrinchus*) and the shortnose sturgeon (*A. brevirostrum*) are found in the river. A few Atlantic sturgeon are taken as a by-catch of the shad fishery, but the population is believed to be larger than the catches indicate.

The river is an important spawning and nursery area for these clupeids and serranids. Rathjen and Miller (1957) found the principal striped bass spawning area to be centered in the vicinity of West Point, about 10 miles north of Peekskill. The most important nursery ground for striped bass was found to be the portion of the river from 15 miles north of Peekskill to about 25 miles south of Peekskill. The authors suggested that the abundance of Crustacea, especially *Gammarus*, and other food organisms attracted the young fish to this portion of the river. Analysis of tag returns (Clark, 1968) indicates that striped bass also overwinter in the Hudson River. And, during a research cruise on the river, Clark (1968) caught 130 striped bass "10 to 25 inches in length, in a 12-minute tow with a 40 ft. trawl" in Haverstraw Bay (5 miles south of Peekskill) in 25 to 40 feet of water.

Shellfish resources in the Hudson River are limited. For many years, seed oysters (*Crassostrea virginica*) were produced in extensive beds below the Tappan Zee Bridge and transplanted to growing areas in Long Island waters. These beds are not presently producing oysters because of the lack of natural set during the past 7 or 8 years (David H. Wallace, personal communication). At the moment, there is no adequate explanation for the lack of set.

The Consolidated Edison Company of New York operates a nuclear-fuel steam electric station adjacent to the Hudson River at Indian Point. River water is pumped through the plant to carry off waste heat from the reactor. In addition, chlorine compounds are periodically introduced into the cooling system to discourage the growth of fouling organisms. The present operation of Unit 1 requires 300,000 gpm of cooling water. During passage through the plant the water is heated an average of 16° F. Units 2 and 3, scheduled for completion by 1970 and 1972, respectively, will each require 900,000 gpm of cooling water with an expected rise in temperature of 17° F. In this part of the river ambient temperatures in late June are in the low 70's (Rathjen and Miller, 1957; Grim, 1967) and presumably are higher later in the summer.

Unit 1 went into operation in January 1963 and almost immediately created conditions that resulted in a fish kill. The exact number of fish that were killed is not known but it was reported as many thousands of individuals. White perch and striped bass were the most common species affected.

The warm-water discharge *per se* was not responsible for the kill. As it was reconstructed later, the fish had been attracted into the heated effluent which was quite near the coolant intake. The fish then were drawn into the intake, lodged against the traveling screens and were taken up into the plant. Three years later, the outfall was redesigned so that the heated water was discharged 200 feet downstream from the intake. A small diversion dam and a sheet-piling baffle were added to further separate the effluent from the intake. In January 1970, another massive fish kill occurred involving more than 150,000 fish, mostly small white perch. The circumstances were essentially the same as those in the 1963 kill.

An ecological study financed by Consolidated Edison was made in the Hudson to evaluate the possible effect of a proposed pump-storage power plant on fish eggs and larvae, especially those of striped bass (Grim, 1967). The study has been completed and a final report was published (Jensen, 1969). Another study is underway to evaluate the effects of the nuclear plants at Indian Point on fish beyond the larval stage.

LONG ISLAND SOUND

The Hudson River has been described as a near-classic estuary. Long Island Sound, on the other hand, is more nearly oceanic. The hydrography of the Sound was described by Riley (1952). It encompasses an area at mean low water of 928.7 nautical square miles with a volume of 61.8 billion cubic meters. It has a rather complicated circulation with an incursion of cold salty water that flows in over the bottom of the sound from a slow southwesterly drift along the Continental Shelf off southern New England. In addition, fresh water equal to 35 per cent of the volume of the sound flows in from a number of river systems, particularly from Connecticut. The less saline water moves west to east at the surface while the salty water from southern New England moves east to west at the bottom. Surface salinity varies from 26 ‰ at the western end of the sound to 30 ‰ at the eastern end. Mean monthly surface temperatures (in degrees Fahrenheit) are as follows.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean	37	36	39	45	54	63	69	71	68	61	52	42
Mean Maximum	41	39	42	50	60	69	73	74	73	67	54	48

Water circulation in the sound is controlled mainly by river drainage, according to Riley (1952). He noted, "Addition of fresh water into the shore zone tends to produce a counterclockwise circulation; however, tidal mixing in areas of little river outflow breaks up the coastal density gradient. The net results appears to be a series of three main eddies—counterclockwise in the east and west ends of L.I.S. with a clockwise eddy between."

Long Island Sound supports important recreational and commercial fisheries for a variety of species. The catches include winter flounder (*Pseudopleuronectes americanus*), striped bass, bluefish (*Pomatomus saltatrix*) and menhaden (*Brevoortia tyrannus*). The shellfish resource includes lobsters (*Homarus americanus*), hard clams (*Mercenaria mercenaria*), oysters, surf clams (*Spisula solidissima*) and mussels (*Mytilus edulis*). Perlmutter (1939) collected eggs and larvae of 12 species of fish in Long Island Sound. These included winter flounder, menhaden and butterfish (*Poronotus triacanthus*).

At the present time there are three fossil-fuel steam electric stations on the New York side of Long Island Sound, i.e., at Glenwood Landing, Northport and Port Jefferson. Three nuclear-fuel plants are planned, i.e., at Davids Island, Lloyds Neck and Shoreham (Figure 1).

GLENWOOD LANDING In Long Island Sound, on the north shore of Long Island, the most westerly steam electric station of the Long Island Lighting Company is the plant at Glenwood Landing. It is located on the eastern side of Hempstead Harbor and produces 410,000 kw of electrical power and about 150,000 gpm of thermal effluent.

The plant is well inside the harbor so that water circulation tends to be sluggish. The power plant site is popular with anglers in the early spring as a place to fish for striped bass. The fish can be found there as early as March, probably attracted by the heated discharge. It is not known if they remain in the harbor the year around. Later in the year, in June, "snapper" bluefish are caught from the plant site. Adult striped bass and bluefish are present in the harbor in August, and the bluefish prey upon an abundant population of silversides. As the seasons progress, flounders enter the harbor near the power plant in late October and are joined by Atlantic mackerel (*Scomber scombrus*) in the middle of November.

Water quality is low in the harbor because of domestic sewage. The high bacteria count has forced the closing of the area to the taking of shellfish.

NORTHPORT In 1912, a steam electric station was built by the Long Island Lighting Company on Northport Harbor. It was demolished and replaced in 1968 by a larger plant near Northport but directly on the sound. The original plant produced 500 kw, whereas the new plant generates 790,000 kw.

The present plant is on the site of what had been extensive sand and gravel mining, and the bottom of the sound there has been thoroughly dredged. Although this bottom formerly produced oysters and clams, it has been so altered that few are now found in the immediate offshore area of the plant. Striped bass, bluefish, flounders and menhaden, however, are seasonally common in the adjacent waters. Water quality there is good with fecal coliforms on the order of <3 mpn/100 ml.²

The two generating units in the plant use a total of 280,000 gpm of coolant water. A third unit, planned for 1972, would add an additional 150,000 gpm. The water is drawn into the plant through a harbor dredged for sand barges. The heated effluent is discharged into a 7-acre lagoon and from there flows over a weir into Long Island Sound. Retention time within the lagoon is approximately $11\frac{1}{2}$ hours. The lagoon is presently used on an experimental basis by a private oyster hatchery as a "nursery" in which to raise seed oysters. The

² Most probable number per 100 milliliters.

TABLE 3. AVERAGE MONTHLY WATER TEMPERATURES* AT THE NORTHPORT STEAM ELECTRIC STATION IN 1968

Month	Inlet	Outlet§	Differential
January	31	52	21
February	30	52	22
March	32	54	22
April	41	63	22
May	50	72	22
June	60	81	21
July	65	88	23
August	70	93	23
September	68	89	21
October	63	85	22
November	47	68	21
December	39	61	22

* In degrees Fahrenheit.

§ The water flowed from the outlet into the lagoon and thence over a weir into Long Island Sound.

nursery has been in operation about a year and its production is not well established. Some representative water temperatures at the plant are shown in Table 3.

During the first 18 months that the new Northport plant operated there were no reports of fish kills. The warm water, however, attracted and held fish during the cold winter months. In November 1968, anglers caught bluefish in the effluent plume in the sound. And in January 1969, they reported catching "4 and 5-pound striped bass" in the plume and observed the bass chasing "baitfish" at the surface. In January 1970, however, several hundred snapper bluefish in the heated plume were killed, apparently when the flow of the effluent was reduced.

Before the plant can begin operation of the planned third generating unit it must be licensed by the State to regulate the manner of discharging the heated effluent. The Department of Environmental Conservation will determine the possible effects of the discharge, based on an ecological study of the area being carried out by the Marine Sciences Research Center of the State University of New York at Stony Brook and financed by the Long Island Lighting Company.

PORT JEFFERSON The first facility of the Long Island Lighting Company plant at Port Jefferson was a 50,000 kw unit built in 1948. A second unit of the same capacity was built in 1950. In 1958 and again in 1960, additional units of 200,000 kw each were built bringing the total output of the plant to 500,000 kw. Between

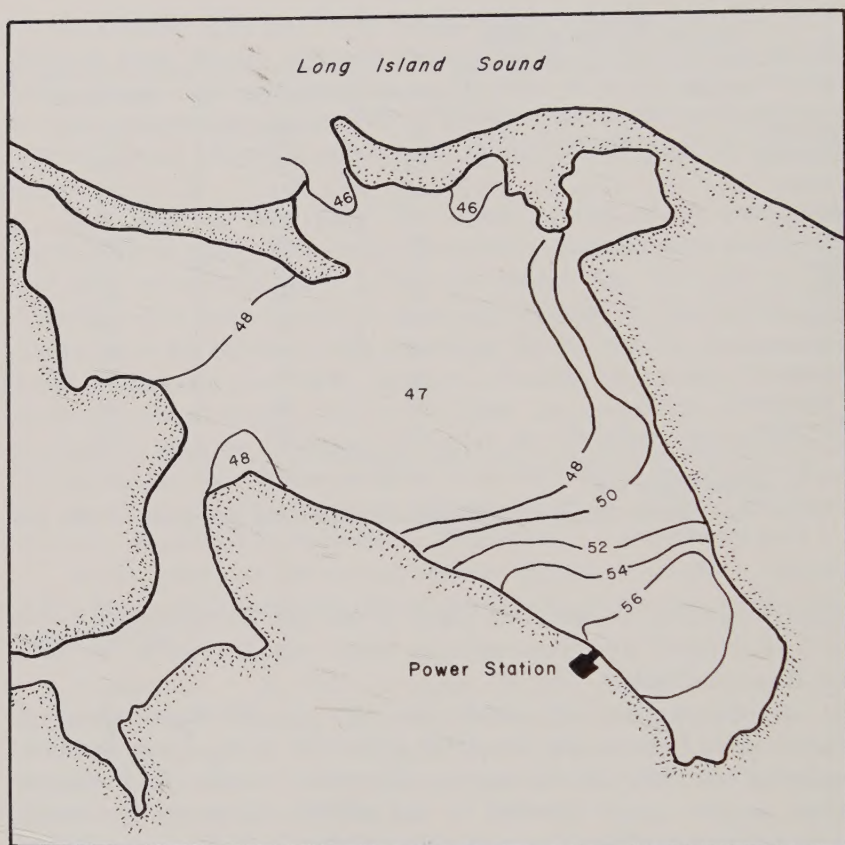


Figure 2. Surface temperatures (in degrees Fahrenheit) in Port Jefferson Harbor 2 hours after low tide on May 10, 1967. The intruding cool water from Long Island Sound was pushing the warm water to the foot of the harbor.

280,000 and 300,000 gpm of coolant water are drawn from and discharged into Port Jefferson Harbor (Figure 2).

The station is located on the western side of the inner part of the harbor. The harbor is narrow, 20 to 40 feet deep, with a tidal range of approximately 7 feet. Salinity averages about 26 ‰. Shellfish in the harbor include hard clams, soft clams (*Mya arenaria*) and mussels, but the entire harbor is closed to the harvest of shellfish because the water is polluted with sewage. In addition, oil pollutants enter the harbor from street runoff and spillage from the tankers that bring fuel to the power plant and to bulk fuel storage plants. Bluefish, menhaden and a variety of bait-fishes are in the harbor waters the year around, presumably attracted by the heated discharge from the station.

Port Jefferson Harbor is surveyed periodically for water quality by the Conservation Department (now the Department of Environmental Conservation). The surveys include determinations of water temperature, salinity, total coliforms, fecal coliforms, dissolved oxygen and biological oxygen demand. Dissolved oxygen averages about 9 ppm. Fecal coliforms vary but have been recorded in recent years as high as 1600 mpn/100 ml. Surface water temperatures recorded on May 10, 1967 are shown in Figure 2. The influence of the heated effluent from the power plant is detectable in the isotherms.

One fish kill has been reported at the Port Jefferson plant and was investigated by personnel from the Conservation Department. On January 26, 27 and 28 in 1966, at least two truckloads of fish were carted away from the plant after having been removed from the traveling screens. In his report, the investigating biologist (John C. Poole) said, "It appears that the warm discharge attracted the fish during a cold snap, they underwent whatever phenomena takes place in these warm-water and intake situations and [that] the mortalities occurred on the traveling screens." The fish were mostly small menhaden (0 and 1-year age groups), but included a few 25-centimeter white perch and one mullet (*Mugil* sp.).

DAVIDS ISLAND Davids Island (formerly U. S. Army Fort Slocum) is being considered by Consolidated Edison as a site for a nuclear-fuel plant capable of producing 4 million kw. It would be one of the largest plants in the world for producing electricity. Coolant water—on the order of 3 million gpm—would be drawn from the immediate environment of the island.

The island is approximately one-half mile long and is separated from the mainland by a one-quarter-mile stretch of shallow water. Although there are channels in the vicinity of the island that are up to 100 feet deep, the surrounding waters are mostly shallow, from 4 to 23 feet deep. The mean tidal range is about 7 feet, but currents around the island are weak and variable.

The local waters are very productive and support an active recreational fishery especially for striped bass and tautog (*Tautoga onitis*). A number of boat liveries and bait shops cater to the recreational fishermen. In recent years, an active commercial and "recreational" lobster fishery has developed in the area. Hard clams are abundant around the island, but the waters are closed to the taking of all shellfish. They are polluted with sewage discharged from plants in nearby Bronx and Westchester Counties.

SHOREHAM The Long Island Lighting Company plans to build a nuclear-fuel station on the north shore of Long Island near

Shoreham. The original plans for the plant were for a generating capacity of 540,000 kw, but forecasts of power demand caused the company to revise their plans. Now, a plant capable of generating 820,000 kw is to be constructed by 1975. The original plant would have used 405,000 gpm of cooling water with an increase of about 20° F. above ambient temperatures. The cooling-water needs anticipated for the larger plant are about 600,000 gpm. The discharge water probably will be raised 20° to 30° F. above ambient temperatures.

The heated effluent is to be discharged 1,600 feet offshore over an area known as Herod Point Shoal. Water depth at the point of discharge is 12 feet. The shoal extends about 1 mile from shore, and the substrate of the near portion is composed primarily of cobbles, sand, gravel and some shell material. The absence of fines in the substrate suggests there is considerable movement of material by bottom currents.

The engineering consultant for the Long Island Lighting Company calculated that the heated effluent will be discharged into the sound as a parabolic plume. Natural turbulence will mix the effluent with the cooler water of the sound so that the temperatures shown in Table 4 are expected.

TABLE 4. TEMPERATURES OF WATERS IN VICINITY OF HEROD POINT SHOAL EXPECTED TO RESULT FROM DISCHARGE OF HEATED EFFLUENT FROM SHOREHAM PLANT OF LONG ISLAND LIGHTING COMPANY.

Horizontal distance from discharge point (feet)	Plume surface temperature above ambient (in degrees Fahrenheit)
200	12.8
600	4.3
1,000	2.6
1,800	1.4

The water there is relatively unproductive compared with that in other parts of Long Island Sound. Tautog and cunners (*Tautoglabrus adspersus*) are resident among the cobbles, while striped bass, bluefish and Atlantic mackerel migrate through the area in season. Mussels are abundant, while lobsters and surf clams are found occasionally. The most abundant fish is the Atlantic silverside (*Menidia menidia*). There is only moderate recreational fishing in the Herod Point Shoal area. A few pots for lobsters are set on the shoal, and there is a commercial fishery for winter flounder farther offshore; commercial fishing there, however, is of minor importance.

Water quality around Herod Point Shoal is good. Fecal coliforms are present but with readings of $<3\text{mpn}/100\text{ml}$.

The Long Island Lighting Company must obtain a permit from the State Department of Environmental Conservation before it can begin discharging the heated effluent from the Shoreham plant. The permit may be granted after review of an ecological study of the Herod Point Shoal area. Financed by the Long Island Lighting Company, the study is being made by Oceanographic Analysts, Inc. of New York City, a private contractor for such studies

LLOYD NECK A power plant, probably nuclear-fueled, is tentatively planned by the Long Island Lighting Company on Lloyd Neck, about 10 miles west of Northport. The company owns the property but does not plan to construct a plant until some time after 1980 (William J. Burns, environmental engineer of the Long Island Lighting Company, personal communication). No estimates have been given as to the possible size of the plant or of its potential thermal effluent. It is safe to assume, however, that it will be about 1 million kw with about 600,000 gpm of effluent heated 20° to 25° F. above ambient.

The cooling water would be drawn from Long Island Sound and probably also discharged into the sound. The ecology of the sound off Lloyd Neck is very similar to that at Northport, and the direct effects of the plant also would be similar to those at Northport. The regional impact of this plant and the volume of effluent have not been considered in the scope of this paper. Plans for the plant are as yet so indefinite that any further consideration here would be pure speculation.

LONG ISLAND SOUTH SHORE

Two fossil-fuel plants of the Long Island Lighting Company operate on the south shore of Long Island at the extreme western end of Nassau County. Both plants discharge thermal effluent into bays that are grossly polluted, and it is difficult to assess the effects of the discharges on the biota of the bays.

The Barrett power station at Island Park on Hempstead Bay is rated at 420,000 kw and discharges 195,500 gpm of water heated to 22° F. above ambient. Intake water temperatures reach a low of 35° F. in February and a high of 75° F. in August. The Far Rockaway power station on Jamaica Bay is rated at 140,000 kw and discharges about 70,000 gpm of water heated to from 15° to 20° F. above ambient. Intake temperatures are similar to those at the Barrett station.

Water movement through both bays is slow and complex because of the series of islands and channels. Hempstead Bay connects

with the Atlantic Ocean through Jones Inlet 5 miles to the east of the power station and through East Rockaway Inlet 5 miles to the west of the power station. The effects of the thermal discharge in the Hempstead Bay estuary are under study by the Town of Hempstead Conservation and Waterways Department.

Jamaica Bay connects with the ocean through Rockaway Inlet about 10 miles west of the Far Rockaway power station. The bay contains a bird sanctuary owned by the City of New York. Although the waters are extremely productive, they are grossly polluted by various petroleum wastes from Kennedy Airport and by the effluent from sewage treatment plants and storm sewers, some of the sewage being dumped raw into the bay.

DISCUSSION

The Sport Fishing Institute has warned that the term "thermal pollution" should be used with discrimination. It should be applied only to those situations where excessive thermal loading is inimical to the interests and needs of mankind. It can, and should, be applied to those situations where the heated discharge has any adverse effects on the waterways and the aquatic organisms in the water.

It is academic, perhaps, to argue whether or not it was thermal pollution that was involved in the fish kills described earlier. There is no direct evidence that the heated water *per se* killed the fish. Nevertheless, it is doubtful that the fish would have been drawn into the intake structures or remained in the area if they had not first been influenced by the thermal discharge. It is not academic, however, to point out that fish that overwinter in the plume of heated discharge probably would be killed in the event of a winter-time plant shutdown. In January, for example, in Long Island Sound, a shutdown would mean the rapid lowering of the surrounding water from 57° to 37° F. Fortunately, because the plants are designed to produce electricity, they are also designed to stay in operation (at least on a partial basis) continuously. A total shutdown, however, is not impossible.

Less dramatic than fish kills but far more long-reaching and, thus, more important, are the permanent ecological changes that may be induced by the total outpourings of the several plants. In Long Island Sound, thermal effluent from the five steam electric stations described here would amount to 8.4 billion gallons per day. While this represents only about one-half of 1 per cent of the total volume of the sound, it does not include the input from stations on the Connecticut shore. The discharge from the Shoreham station alone is expected to raise the temperature of the sound by 0.02° F. (Long Island Lighting Company, 1968). The outpouring of more than 8 billion gallons per

day of thermal discharge can be expected to raise the temperature of the sound higher than that. We can not say for certain what the long-range, regional ecological effects will be, but they most certainly will occur and probably will be unpleasant and undesirable.

The effects of thermal discharge in conjunction with sewage discharge must also be considered. The situation is potentially most acute at the western end of the sound with respect to the sewage discharge from New York City (The Bronx) and, to a lesser extent, from Westchester County. Westchester now employs secondary treatment for all its sewage, but the levels of nitrates and phosphates being poured into western Long Island Sound are tremendous. At water temperatures which now prevail, these nutrients do not create toxic blooms of algae or excessive plant growth except very locally. With the addition of higher temperature water, such problems may become extremely important. Furthermore, while coliform bacteria tend to die in salt water, the load currently has been at least equal to the die-off rate. Since bacteria multiply rapidly as the temperature increases, the input of heat by the effluent from steam electric stations could trigger a rapid further deterioration of water quality.

At present, there is only the one user of thermal discharge—the oyster nursery—and it must be emphasized strongly that this possible beneficial use does not eliminate the potential danger of heated effluents to the ecology of the State's marine environment. The amount of heated water that could be used for beneficial biological purposes is a very small percentage of the total volume needed for cooling purposes. The remainder of the flow must be handled in such a manner as to eliminate danger to the marine environment.

CONCLUSIONS

In Long Island Sound where the total volume of salt water is very great, the direct thermal effects from a single plant probably would be limited to a small area around the outfall. In the Hudson River the effects of a single plant would be more far reaching. The cumulative effects of many discharges in both areas certainly will be sufficient to substantially modify the regional water characteristics of the Marine District. It is important, therefore, in dealing with the problem of thermal pollution, to carry out planning studies to determine the number, location and volume of discharge which the environment can safely tolerate. Research programs would need to be adequately financed and carefully carried out to help understand the ecology of the marine waters and the limits of tolerance of the member organisms. With the needed biological data, the planners could base their judgments on those data and not on imagination or conjecture.

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DEFINITION OF HUMAN RESIDENCE ZONES IN NEW YORK¹

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ABSTRACT

On the basis of broad ecological differences combined with differences in the distribution of the human population, 21 human residence zones, 10 urban and 11 rural, are defined.

Knowledge of the origin of those who hunt in different parts of the State is valuable in interpreting data on hunting pressure, success ratio, manner of hunting and degree of reporting game taken. Such information is useful not only for analyzing the results of past seasons but also for developing future regulations, especially with respect to special seasons or hunting pursuant to special permits. For the purpose of correlating data with the origin of the hunters involved, information on hunter residence has been compiled according to broad regional categories or by the county of license purchase. These breakdowns are not wholly satisfactory because they often do not represent groups of hunters with similar backgrounds and interests. There is need for a breakdown that would be more nearly representative in this respect. This paper defines 21 residence zones based on human ecology.

Smith (1954) divided the State into 11 game range divisions on the basis of differences in geology, topography, physiography, climate, soils, vegetation, water areas and other related natural characteristics. With Smith's game divisions as a guide, but using the nearest town boundary, McCaffrey (1966) defined 10 sections for purposes of deer management. Such ecological classifications are useful for studying wildlife populations. However, a different sort of classification is needed for hunters; i.e., one based on human ecology as well as natural ecology.

The character of the land's surface, as well as what is underground, has a considerable effect on man's activities. This is particularly apparent in his use of the land and the location of his industries. Reflecting this, different industrial, wage and cultural groups develop whose broad attitudes and interests differ. Human ecological groups may be industrial (blue collar) urban, white collar urban, valley rural, hill country rural, etc.

¹ A contribution of Federal Aid in Fish and Wildlife Restoration Project W-90-R.

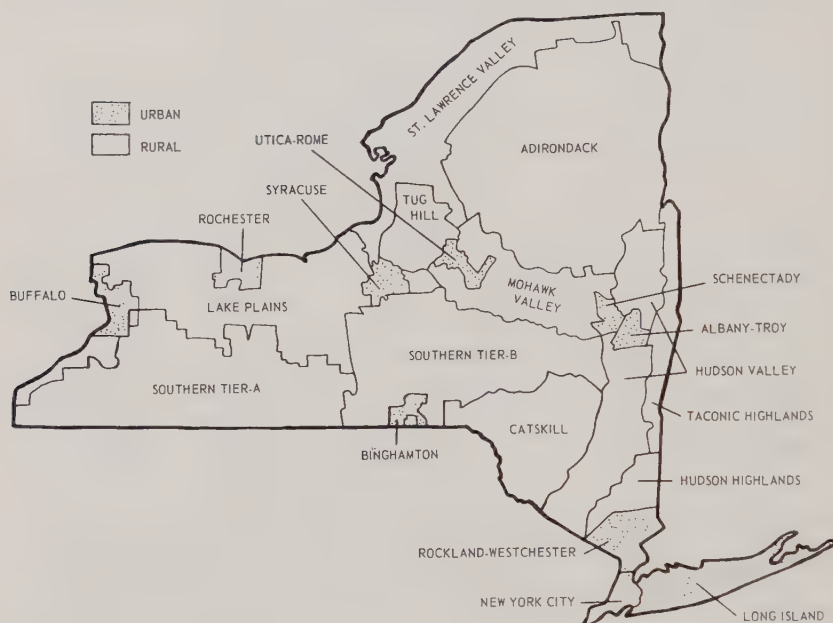


Figure 1. Human residence zones in New York.

In defining human residence zones in New York, the deer-management sections were used as a base, and the "urbanized areas" within each, as designated by the 1960 Federal census (United States Bureau of Census, 1961), were considered separate zones.² The urbanized areas, however, do not follow political boundaries, which would be best for analyzing residence data. Therefore, each urban area was increased to include all of any town involved since it was felt that this would not change the distribution significantly. The remainder of whatever sections were involved was considered rural although city areas of less than 50,000 population may have been included.

On this basis, the State was divided into 21 human residence zones: 10 urban and 11 rural. All non-residents may then be considered as a 22nd zone. These 21 zones are shown in Figure 1, and the counties and towns included in each are listed in Table 1.

Although experience will probably lead to some refinement of these zones, they are considered to provide for a classification of hunter residence more representative of differences in character among the groups involved than previously used categories have been. Data

² An "urbanized area" is a city or group of cities with a population of 50,000 or more, together with its urban fringe.

TABLE 1. HUMAN RESIDENCE ZONES IN NEW YORK STATE AND COUNTIES AND TOWNS COMPRISING EACH

Zone	Area included	
	Counties	Towns
		Rural
Adirondack	Clinton	Ausable, Black Brook, Dannemora, Ellenburg, Peru, Saranac, Schuylcr Falls
	Essex	all
	Franklin	Altamont, Bellmont, Brandon, Brighton, Dickinson, Duane, Franklin, Harrietstown, Malone, Santa Clara, Waverly
	Fulton	Bleeker, Caroga, Mayfield, Northhampton, Stratford
	Hamilton	all
	Herkimer	Ohio, Salisbury, Webb
	Lewis	Croghan, Diana, Greig, Lyonsdale, New Bremen, Watson
	Oneida	Forestport
	St. Lawrence	Clare, Clifton, Colton, Edwards, Fine, Fowler, Hermon, Hopkinton, Parishville, Piercefield, Pierrepont, Pitcairn, Russell
	Saratoga	Corinth, Day, Edinburg, Greenfield, Hadley, Providence
	Warren	Bolton, Caldwell, Chester, Hague, Horicon, Johnsburg, Luzerne, Stony Creek, Thurman, Warrensburg
	Washington	Dresden, Fort Ann, Putnam
Catskill	Broome	Sanford
	Delaware	Andes, Colchester, Deposit, Hamden, Hancock, Middletown, Roxbury, Tompkins, Walton
	Greene	Ashland, Halcott, Hunter, Jewett, Lexington, Prattsville, Windham
	Orange	Deerpark, Port Jarvis City
	Sullivan	all
	Ulster	Denning, Hardenburg, Hurley, Marbletown, Olive, Rochester, Shandaken, Wawarsing, Woodstock
Hudson Highlands	Dutchess	Beacon City, Beekman, Dover, East Fishkill, Fishkill, Pawling, Union Vale
	Orange	Cornwall, Highlands, Monroe, Tuxedo, Woodbury
	Putnam	all
Hudson Valley	Albany	Coeymans, New Scotland
	Columbia	Chatham, Claverack, Clermont, Gallatin, Germantown, Ghent, Greenport, Hudson City, Kinderhook, Livingston, Stockport, Stuyvesant, Taghkanic
	Dutchess	Clinton, Hyde Park, La Grange, Milan, Pine Plains, Pleasant Valley, Poughkeepsie, Poughkeepsie City, Red Hook, Rhinebeck, Stanford, Wappinger, Washington
	Greene	Athens, Catskill, Coxsackie, New Baltimore

TABLE 1. (continued)

Zone	Area included	
	Counties	Towns
	Orange	Blooming Grove, Chester, Crawford, Goshen, Greenville, Hamptonburgh, Middletown City, Minisink, Montgomery, Mount Hope, Newburgh, Newburgh City, New Windsor, Walkill, Warwick, Wawayanda
	Rensselaer	Brunswick, Pittstown, Schaghticoke, Schodack
	Saratoga	Ballston, Clifton Park, Halfmoon, Malta, Mechanicville City, Moreau, Northumberland, Saratoga, Saratoga Springs City, Stillwater, Wilton.
	Ulster	Esopus, Gardiner, Kingston, Kingston City, Lloyd, Marlborough, New Paltz, Plattekill, Rosendale, Saugerties, Shawangunk, Ulster
	Warren	Glens Falls City, Queensbury
	Washington	Argyle, Cambridge, Easton, Fort Edward, Greenwich, Hartford, Kingsbury
Lake Plains	Cayuga	Auburn City, Aurelius, Brutus, Cato, Conquest, Fleming, Genoa, Ira, Ledyard, Mentz, Montezuma, Owasco, Scipio, Sennett, Springport, Sterling, Throop, Venice, Victory
	Chautauqua	Dunkirk, Dunkirk City, Hanover, Pomfret, Portland, Ripley, Sheridan, Westfield
	Erie	Alden, Brant, Clarence, Collins, Eden, Elma, Evans, Newstead, North Collins
	Genesee	all
	Livingston	Avon, Caledonia, Geneseo, Groveland, Leicester, Lima, Livonia, Mount Morris, North Dansville, Sparta, West Sparta, York
	Madison	Lenox, Lincoln, Oneida City, Sullivan
	Monroe	Clarkson, Hamlin, Henrietta, Mendon, Ogden, Parma, Riga, Rush, Sweden, Wheatland
	Niagara	Cambria, Hartland, Lockport, Lockport City, Newfane, Pendleton, Porter, Royalton, Somerset, Wheatfield, Wilson
	Onondaga	Elbridge, Lysander, Marcellus, Skaneateles, Van Buren
	Ontario	Bristol, Canandaigua, Canandaigua City, East Bloomfield, Farmington, Geneva, Geneva City, Gorham, Hopewell, Manchester, Phelps, Richmond, Seneca, Victor, West Bloomfield
	Orleans	all
	Oswego	Granby, Hannibal, Minetta, Oswego
	Seneca	all
	Tompkins	Ithaca, Ithaca City, Lansing, Ulysses
	Wayne	all
	Wyoming	Attica, Castile, Covington, Middlebury, Perry, Warsaw
	Yates	Barrington, Benton, Jerusalem, Milo, Potter, Starkey, Torrey
Mohawk Valley	Albany	Knox
	Fulton	Broadalbin, Ephratah, Gloversville City, Johnstown, Johnstown City, Oppenheim, Perth

TABLE 1. (*continued*)

Zone	Area included	
	Counties	Towns
	Herkimer	Columbia, Danube, Fairfield, Frankfort, German Flats, Herkimer, Litchfield, Little Falls, Little Falls City, Manheim, Newport, Norway, Russia, Schuyler, Stark, Warren, Winfield
	Montgomery	all
	Oneida	Augusta, Boonville, Bridgewater, Floyd, Kirkland, Marcy, Marshall, Paris, Remsen, Sangerfield, Steuben, Trenton, Vernon, Verona, Western, Westmoreland
	Otsego	Cherry Valley, Richfield, Springfield
	Saratoga	Charlton, Galway, Milton
	Schenectady	Duanesburg, Princetown
	Schoharie	Carlisle, Cobleskill, Esperance, Middleburgh, Schoharie, Sharon, Wright
St. Lawrence Valley	Clinton	Altona, Beekmantown, Champlain, Chazy, Clinton, Mooers, Plattsburg, Plattsburg City
	Franklin	Bangor, Bombay, Burke, Chateaugay, Constable, Fort Covington, Moira, Westville
	Jefferson	Adams, Alexandria, Antwerp, Brownville, Cape Vincent, Champion, Clayton, Ellisburg, Henderson, Hounsfield, Le Ray, Lyme, Orleans, Pamela, Philadelphia, Rodman, Rutland, Theresa, Watertown, Watertown City, Wilna
	Lewis	Denmark, Harrisburg, Leyden, Lowville, Martinsburg, Pinckney, Turin, West Turin
	Oswego	Fulton City, Mexico, New Haven, Oswego City, Palermo, Richland, Sandy Creek, Schroepfel, Scriba, Volney
	St. Lawrence	Brasher, Canton, DeKalb, DePeyster, Gouverneur, Hammond, Lawrence, Lisbon, Louisville, Macomb, Madrid, Massena, Morristown, Norfolk, Ogdensburg City, Oswegatchie, Potsdam, Rossie, Stockholm, Waddington
Southern Tier-A	Alleghany	all
	Cattaraugus	all
	Chautauqua	Arkwright, Busti, Carroll, Charlotte, Chautauqua, Cherry Creek, Clymer, Ellery, Ellicott, Ellington, French Creek, Gerry, Harmony, Jamestown City, Kiantone, Mina, North Harmony, Poland, Sherman, Stockton, Villanova
	Chemung	all
	Erie	Aurora, Boston, Colden, Concord, Holland, Marilla, Sardinia, Wales
	Livingston	Conesus, Nunda, Ossian, Portage, Springwater
	Ontario	Canadice, Naples, South Bristol
	Schuyler	Catherine, Cayuta, Dix, Hector, Montour, Orangetown, Reading, Tyrone
	Stueben	all
Tompkins		Danby, Enfield, Newfield
	Wyoming	Arcade, Bennington, Eagle, Gainesville, Genesee Falls, Java, Orangeville, Pike, Sheldon, Wethersfield
	Yates	Italy, Middlesex

TABLE 1. (continued)

Zone	Area included	
	Counties	Towns
Southern Tier-B	Albany	Berne, Rensselaerville, Westerlo
	Broome	Barker, Binghamton, Colesville, Kirkwood, Lisle, Maine, Nanticoke, Triangle, Windsor
	Cayuga	Locke, Moravia, Niles, Sempronius, Summerhill
	Chenango	all
	Cortland	all
	Delaware	Bovina, Davenport, Delhi, Franklin, Harpersfield, Kortright, Masonville, Meredith, Sidney, Stamford
	Greene	Cairo, Durham, Greenville
	Madison	Brookfield, Cazenovia, DeRuyter, Eaton, Fenners, Georgetown, Hamilton, Lebanon, Madison, Nelson, Smithfield, Stockbridge
	Onondaga	Fabius, Lafayette, Otisco, Pompey, Spafford, Tully
	Otsego	Burlington, Butternuts, Decatur, Edmeston, Exeter, Hartwick, Laurens, Maryland, Middlefield, Milford, Morris, New Lisbon, Oneonta, Oneonta City, Otsego, Otsego, Pittsfield, Plainfield, Roseboom, Unadilla, Westford, Worcester
Taconic Highland	Schoharie	Blenheim, Broome, Conesville, Fulton, Gilboa, Jefferson, Richmondville, Seward, Summit
	Tioga	all
	Tompkins	Caroline, Dryden, Groton
Tug Hill	Columbia	Ancram, Austerlitz, Canaan, Copake, Hillsdale, New Lebanon
	Dutchess	Amenia, Northeast
	Rensselaer	Berlin, Grafton, Hoosick, Nassau, Petersburg, Poestenkill, Sand Lake, Stephentown
Tug Hill	Washington	Granville, Hampton, Hebron, Jackson, Salem, White Creek, Whitehall
Tug Hill	Jefferson	Lorraine, Worth
	Lewis	High Market, Lewis, Montague, Osceola
	Oneida	Annsville, Ava, Camden, Florence, Vienna
	Oswego	Albion, Amboy, Boylston, Constantia, Hastings, Orwell, Parish, Redfield, West Monroe, Williamstown
Tug Hill		
		Urban
Albany-Troy	Albany	Albany City, Bethlehem, Cohoes City, Colonie, Green Island, Guilderland, Watervliet City
	Rensselaer	East Greenbush, North Greenbush, Rensselaer City, Troy City
	Saratoga	Waterford
Binghamton	Broome	Binghamton City, Chenango, Conklin, Dickin-son, Fenton, Union, Vestal

TABLE 1. (continued)

Zone	Area included	
	Counties	Towns
Buffalo	Erie Niagara	Amherst, Buffalo City, Cheektowaga, Grand Island, Hamburg, Lackawanna City, Lancaster, Orchard Park, Tonawanda, Tonawanda City, West Seneca Lewiston, Niagara, Niagara Falls City, North Tonawanda City
Long Island	Nassau Suffolk	all all
New York City	Bronx Kings New York Queens Richmond	
Rochester	Monroe	Brighton, Chili, Gates, Greece, Irondequoit, Penfield, Perinton, Pittsford, Rochester City, Webster
Rockland-Westchester	Rockland Westchester	all all
Schenectady	Schenectady	Glenville, Niskayuna, Rotterdam, Schenectady City
Syracuse	Onondaga	Camillus, Cicero, Clay, DeWitt, Geddes, Manlius, Onondaga, Salina, Syracuse City
Utica-Rome	Oneida	Deerfield, Lee, New Hartford, Rome City, Utica City, Whitestown

pertaining to hunter activities may be readily tabulated according to zone by obtaining the residence post office zip codes of the hunters for whom information is recorded.

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DISTRIBUTION OF BIG GAME LICENSEES IN NEW YORK¹

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ABSTRACT

A random sample of people who purchased big game and special archery licenses in 1965 was grouped by residence zone, and the total number in each zone was computed. Their distribution and the proportion of total license sales for the various zones are presented as well as comparisons with the total population. Big game hunters were not evenly distributed, and proportions varied from one licensee for every 6.4 people in the Catskills to one for every 167 people in New York City. In all the rural zones and most of the upstate urban zones, the proportion of total license sales was greater than the proportion of the total population that resided there.

Knowledge of what proportion of the State's population engages in hunting and of the relative distribution of these hunters over the State can be important in determining game management policy. Data on the distribution of big game hunters were compiled

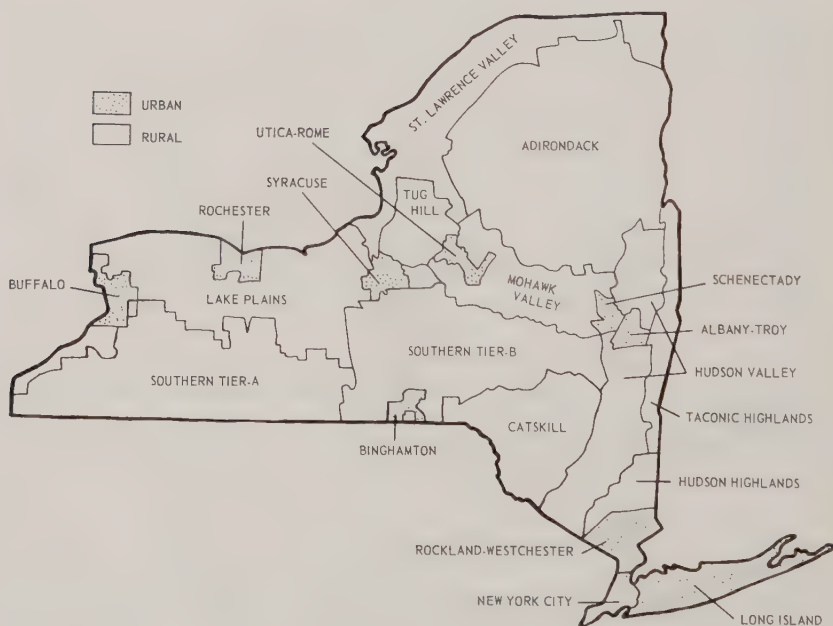


Figure 1. Human residence zones in New York. (After Severinghaus and Eabry, 1970).

¹A contribution of Federal Aid in Fish and Wildlife Restoration Project W-90-R.

from the records of those who purchased big game licenses and special archery licenses in 1965.

A random sample of 44,498 license stubs was selected. The residences of the licensees in the sample were tabulated by post office zip code. They were then grouped according to the residence zones (Figure 1) defined by Severinghaus and Eabry (1970). The sample represented 8.5 per cent of the total license sales in 1965. Using this as a factor, the total license sales for each zone were computed (Table 1), and the corresponding percentages of the statewide resident license sales were determined. These are illustrated in Figure 2 and given in Table 1 together with the percentage of the total State population that resided in each zone.

TABLE 1. DISTRIBUTION OF BIG GAME AND SPECIAL ARCHERY LICENCE HOLDERS AND STATE POPULATION BY RESIDENCE ZONE IN 1965

Zone	Computed number of licensees	Percentage of resident license sales	Percentage of State population§
Lake Plains*	61,386	12.2	4.7
Southern Tier-A*	50,347	10.0	2.9
New York City**	48,987	9.8	46.4
Buffalo**	38,182	7.6	6.6
Hudson Valley*	36,166	7.2	3.4
Southern Tier-B*	34,396	6.8	1.8
Long Island**	32,861	6.5	11.8
St. Lawrence*	28,138	5.6	1.9
Adirondack*	22,724	4.5	0.9
Rochester**	21,540	4.3	3.2
Mohawk Valley*	19,758	3.9	1.5
Rockland-Westchester**	17,907	3.6	5.6
Catskill*	17,896	3.6	0.7
Syracuse**	16,419	3.3	2.2
Binghamton**	14,638	2.9	1.1
Utica-Rome**	9,247	1.8	1.2
Albany-Troy**	8,239	1.6	2.1
Schenectady**	7,782	1.6	0.9
Taconic Highlands*	5,989	1.2	0.3
Hudson Highlands*	5,883	1.2	0.6
Tug Hill*	3,832	0.8	0.2
Rural	286,515	57.0	18.9
Urban	215,802	43.0	81.1
Total resident	502,317	100.0	100.0
Out-of-State	19,173	xxx	xxx
Total	521,490	100.0	100.0

* Rural.

** Urban.

§ Derived from Federal census (see text).

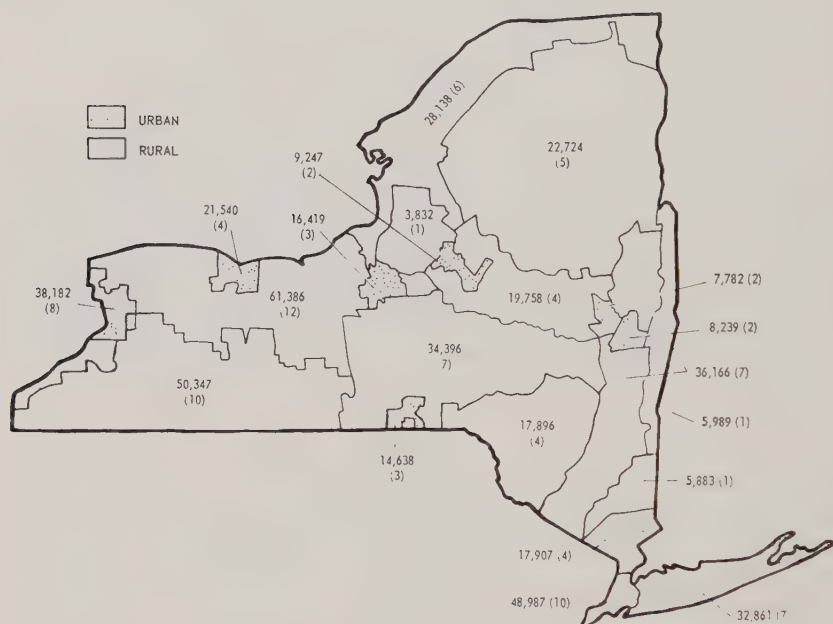


Figure 2. Number of resident big game and special archery license holders and percentage of total licensees by residence zone in 1965. Percentages are rounded, see Table 1.

The distribution of the population of the State in 1965 was derived from figures for the 1960 Federal census as published by the New York State Department of Commerce (1963). These figures were uniformly increased by a factor of 0.0518 furnished by the State Department of Health as an estimate of the statewide increase in population from 1960 to 1965.

The two rural zones of western New York ranked first and second in the number of licensees. Of the total, 57 per cent were from rural zones, although 19 per cent of the population resided in these areas. In contrast, 43 per cent were from urban zones where 81 per cent of the population resided.

Out-of-state licensees in the sample came from 23 states (Table 2), including all of New England, and from as far as Florida and California. Non-resident hunters from New Jersey were the largest group, constituting about 62 per cent of the total and representing some 11,860 actual licensees.

The proportion of the population in each zone who held a big game or special archery license was calculated for the total population and for males 16 years of age or over (Table 3). The number of males 16 years of age or over was determined by multiplying the pop-

TABLE 2. DISTRIBUTION OF NON-RESIDENT BIG GAME AND SPECIAL ARCHERY LICENSE HOLDERS BY STATES IN 1965

State	Number in sample
New Jersey	1,012
Pennsylvania	239
Connecticut	176
Ohio	66
Massachusetts	60
Vermont	15
Maryland	12
Florida	8
Illinois	8
Virginia	8
Indiana	7
Michigan	6
Delaware	4
California	2
Maine	2
New Hampshire	2
North Carolina	2
Rhode Island	2
Alabama	1
Nebraska	1
New Mexico	1
Oklahoma	1
West Virginia	1
Total	1,636

ulation figures by a factor of 0.336 which was derived from age-structure data given in the Federal census records for 1960 (New York State Department of Commerce, 1963). The percentages by zone with respect to the total population are illustrated in Figure 3. The relationship is also expressed in Table 3 in terms of the number of individuals per licensee in the population of each zone.

It is evident that big game hunters were not evenly distributed over the State and that there are great differences in the proportion of licensees in the population in the various zones. Proportions varied from one licensee for every 6.4 people in the Catskills to one for every 167 people in New York City.

For all the rural zones, the proportion of total license sales was greater than the proportion of the total population that resided there, and the same was true for the urban zones of Binghamton, Buffalo, Rochester, Schenectady, Syracuse and Utica-Rome. On the other hand, the reverse was the case for the urban zones of Albany-Troy, Long Island, New York City and Rockland-Westchester.

TABLE 3. PROPORTION OF TOTAL POPULATION AND OF MALES 16 YEARS OF AGE OR OVER IN EACH RESIDENCE ZONE THAT HELD BIG GAME OR SPECIAL ARCHERY LICENSE IN 1965

Zone	Total Population		Males 16 years or over	
	Percentage that held license	Individuals per license	Percentage that held license§	Individuals per license§
Catskill*	15.6	6.4	46.3	2.2
Adirondack*	13.9	7.2	41.2	2.4
Tug Hill*	12.2	8.2	36.4	2.7
Southern Tier-B*	11.1	9.0	33.1	3.0
Taconic Highlands*	10.1	9.9	30.0	3.3
Southern Tier-A*	9.7	10.3	28.8	3.5
St. Lawrence*	8.3	12.1	24.6	4.1
Mohawk Valley*	7.5	13.3	22.4	4.5
Binghamton**	7.5	13.3	22.4	4.5
Lake Plains*	7.4	13.5	22.1	4.5
Hudson Valley*	6.0	16.6	17.9	5.6
Hudson Highlands*	5.3	18.9	15.7	6.4
Schenectady**	4.9	20.3	14.6	6.8
Utica-Rome**	4.4	22.6	13.2	7.6
Syracuse**	4.1	24.1	12.4	8.1
Rochester**	3.8	26.0	11.4	8.8
Buffalo**	3.3	30.6	9.7	10.3
Albany-Troy**	2.2	46.0	6.5	15.4
Rockland-Westchester**	1.8	55.5	5.4	18.5
Long Island**	1.6	63.0	4.7	21.3
New York City**	0.6	167.1	1.8	55.6
Rural	8.5	11.7	25.5	3.9
Urban	1.5	66.3	4.5	22.2
Total	2.8	35.1	8.5	11.8

* Rural.

** Urban.

§ In calculating these ratios, no account was taken of the small number of women who buy these licenses.

Among the urban zones, the proportion of big game hunters in the population was much higher in those upstate, except the Albany-Troy zone, than in those close to New York City. In fact, the Binghamton zone might be considered as rural in this respect.

Of interest, is the marked difference between the Albany-Troy and Schenectady zones and the pattern formed by the contiguous zones of Albany-Troy (2.2 per cent), Schenectady (4.9 per cent), Mohawk Valley (7.5 per cent) and Southern Tier-B (11.1 per cent) as shown in Figure 3. This seems to reflect social differences, i.e., white collar urban, blue collar urban, valley rural and hill country rural, respectively, as discussed by Severinghaus and Eabry (1970).

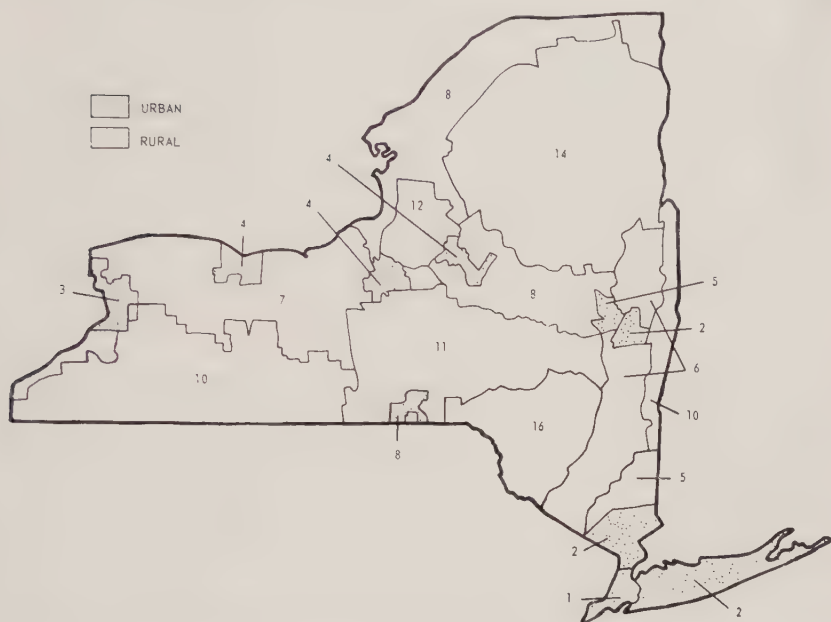


Figure 3. Percentage of total population that held big game or special archery license in 1965 by residence zone. Percentages are rounded, see Table 3.

The number of licensees from New Jersey, calculated as 11,860, was larger than that of three urban and three rural zones of New York as well as being much greater than that of other adjoining states. This was probably due to both the high population density in New Jersey near the State boundary and the comparatively low level of big game hunting opportunity there.

Information on the characteristics of hunters in different parts of the State is becoming increasingly important in developing game management programs. Hunter distribution and the relative magnitude of component groups are a major element. Such data are presented here for big game hunters. Correlated with knowledge of the attitudes, interests and idiosyncrasies of hunters in the various zones, they should aid materially in guiding deer management.

Another aspect of this sort of information relates to public relations and education. An average of 35 persons did not buy a license to hunt big game for each one who did. The proportion was much higher in the urban zones than in the rural zones, ranging to 167 in New York City. It is probable that a similar pattern exists among those who hunt other species. In promoting public understanding and support of conservation policies and programs it may often be advantageous to make special efforts to reach these non-hunters.

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PARASITES OF YELLOW PERCH IN ONEIDA LAKE NEW YORK¹

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ABSTRACT

Parasites of 54 yellow perch from Oneida Lake, New York, in 1966 were compared with those found over 35 years earlier. The trematodes *Tetracotyle* sp., *Apophallus brevis* and *Urocleidus adspetus*, previously unrecorded from perch in Oneida Lake, have become common, but *Clinostomum marginatum*, previously common, was not found. Some of these changes may be related to changes in the bottom fauna. Changes in incidence of other trematodes, cestodes, acanthocephalans and nematodes were probably the result of areal and seasonal differences in sampling.

An intensive investigation of the parasites of fishes of Oneida Lake was conducted by Van Cleave and Mueller (1934) from 1928 to 1931. Since that time, at least three additional species of fish have entered the lake (Dence and Jackson, 1959) and there has been a marked change in the composition of the bottom fauna (Jacobsen, 1966; Noble, 1969). Parasites of the yellow perch (*Perca flavescens*) were examined in 1966 to determine possible effects of these changes over the 35-year period on the parasite fauna.

MATERIALS AND METHODS

From March 31 to December 1 in 1966, 54 yellow perch ranging from 7 to 30 centimeters in total length were collected from various areas in Oneida Lake and examined for external and internal parasites. The mouth, skin and visceral peritoneum were examined superficially, and the internal organs, eyes, gills and fins were dissected to remove the parasites. A longitudinal slice of the lateral trunk muscles was removed from the dorsum of each fish and teased apart to extricate metacercarial cysts. The blood and brain were not examined. The parasites, exclusive of nematodes, were fixed in AFA solution for 12 to 48 hours before transfer to 70 per cent ethanol. Permanent mounts were made by staining with Semichon's acetocarmine, clearing with beechwood creosote or terpineol, and mounting in balsam. Nematodes were fixed and stored in glycerin alcohol. Nematodes and some monogenetic trematodes were mounted unstained in glycerin jelly. Common parasites were sometimes identified alive and discarded.

RESULTS

Parasites found in 1966 and 1928-1931 are listed in Table 1 and their frequencies of occurrence are compared.

¹ A contribution of Federal Aid in Fish and Wildlife Restoration Project F-17-R.

TABLE 1. COMPARISON OF PERCENTAGE INCIDENCE OF PARASITES OF YELLOW PERCH IN ONEIDA LAKE IN 1966 WITH RECORDS FOR 1928-1931

Parasite	1966	1928-31§
Trematoda		
<i>Urocleidus adspetus</i>	41	..
<i>Phyllodistomum superbum</i>	9	common (40)
<i>Crepidostomum cooperi</i>	74	common (25)
<i>Bunodera sacculata</i>	31	occasional
<i>Bunodera luciopercae</i>	..	rare
<i>Centrovarium lobotes</i>	..	occasional
<i>Apophallus americanus*</i>	..	accidental
<i>Apophallus brevis*</i>	37	..
<i>Maritrema medium*</i>	..	rare
<i>Clinostomum marginatum*</i>	..	common
<i>Diplostomum huronense*</i>	100	abundant
<i>Diplostomulum scheuringi*</i>	9	common
<i>Neascus</i> sp.*	17	common
<i>Tetracotyle</i> sp.*	61	accidental
<i>Azygia angusticauda</i>	39	common (15)
<i>Bucephalus elegans</i>	9	common (30)
<i>Neochasminae*</i>	2	..
Cestoda		
<i>Ligula intestinalis*</i>	..	occasional (2)
<i>Bothriocephalus cuspidatus*</i>	54	present
<i>Bothriocephalus cuspidatus</i>	7	..
<i>Proteocephalus pearsei*</i>	28	occasional (10)
<i>Proteocephalus pearsei</i>	6	present
<i>Proteocephalus ambloplites*</i>	56	occasional
<i>Proteocephalus</i> sp.*	20	present
Acanthocephala		
<i>Neoechinorhynchus cylindratus</i>	39	common
<i>Leptorhynchoides thecatus</i>	6	occasional
<i>Pomphorhynchus bulbocollis</i>	..	rare
Nematoda		
<i>Dacnitioides cotylophora</i>	17	abundant (60)
<i>Spinitectus</i> sp.	2	common
<i>Philometra cylindracea</i>	4	occasional (12)
Copepoda		
<i>Ergasilus caeruleus</i>	30	undetermined
Number of perch examined	54	273

* Immature stage.

§ Figures in parentheses represent only percentages reported.

TREMATODES

Several trematodes previously unrecorded from perch in Oneida Lake have become common. The most pronounced change was the appearance of *Tetracotyle* sp. metacercariae in 61 per cent of the perch examined in 1966. Masses of up to 250 *Tetracotyle* occurred in the pericardial cavity, whereas individual metacercariae were sometimes found in the visceral mesenteries and behind the eyes. Although similar sites of infection in yellow perch have been reported for *T. diminuta* by Hoffman (1967), only pseudo-infections of the in-

testinal tracts of perch from Oneida Lake were found by Van Cleave and Mueller (1934). They hypothesized at the time that hard-bodied fishes were not susceptible to infection by *Tetracotyle*.

Metacercariae of *Apophallus brevis*, also previously unrecorded, were found in 1966. Van Cleave and Mueller reported rare accidental infections of perch intestines by *A. americanus*, but the 1966 survey revealed 37 per cent infection by *A. brevis*. These were found in the musculature and surrounded by hard cysts. An incidence of 90 per cent was reported by Sinclair (1969) who examined the entire lateral musculature of 324 perch from Oneida Lake.

A monogenetic trematode, *Urocleidus adspectus*, was found on the gills of 41 per cent of the perch examined in 1966. Since Van Cleave and Mueller found a monogenetic trematode of the same genus on the gills of the walleye (*Stizostedion v. vitreum*) they closely examined perch for monogenetic trematodes, but found none. Mueller (1936) found *U. adspectus* on perch in Cross Lake, New York, located in the same drainage as Oneida Lake and only about 35 miles away via the New York State Barge Canal.

A new host record was established for the trematode subfamily Neochasminae with the discovery of an echinostome encysted in the eye of one perch. This was probably an accidental infection of *Neochasmus* sp. or *Allocanthochasmus* sp. which occur as adults in other fishes of Oneida Lake (Van Cleave and Mueller, 1934).

Diplostomum huronense, a metacercaria of the vitreous humor, was the only trematode listed by Van Cleave and Mueller as abundant. In the 1966 survey, all of the perch examined were infected. As many as 735 of the parasites were removed from the eyes of an individual fish. These metacercariae sometimes formed dense mats on the retina and invaded the lens of the eye, without noticeable effect on condition of the fish.

Crepidostomum cooperi was the only adult digenetic trematode which occurred frequently. It was found in the intestines of 74 per cent of the perch and was sometimes represented by over 100 individuals. The parasite was considerably less frequent in the earlier study, occurring in only 25 per cent of the perch.

The only parasite which was previously common but not recorded in the present investigation was the metacercaria of *Clinostomum marginatum*, the yellow grub. This parasite is typically prevalent in shallow, protected waters, which were not well sampled in the present study. However, large numbers of adult yellow perch have been handled annually for several years without a single incidence of this sometimes conspicuous parasite having been noted.

CESTODES

The main change found among cestodes was the presence of *Bothriocephalus cuspidatus* adults in the recent study. Of four fish parasitized, three were found during late fall. Van Cleave and Mueller, although noting an occasional "slight approach toward sexual maturity", may have missed the adult form because they sampled primarily during the summer months. Adults have been commonly reported from yellow perch elsewhere (Hoffman, 1967).

Plerocercoids of *Bothriocephalus cuspidatus* and *Proteocephalus ambloplites* were the most common cestodes in the 1966 survey, each occurring in over half of the perch examined. In some hosts, nearly 100 immature *B. cuspidatus* occupied the small intestine, and in some cases up to 15 *P. ambloplites* occupied the liver. Plerocercoids of both species were present in the earlier study.

Ligula intestinalis was not recorded in the 1966 survey; however, in late summer of 1968, plerocercoids were frequently observed in the body cavities of young perch from Oneida Lake.

ACANTHOCEPHALANS

No apparent change in acanthocephalan parasitism has taken place since 1931. *Neochrinorhynchus cylindratus* remained the only common species, with *Leptorhynchoides thecatus* occurring occasionally. *Pomphorhynchus bulbocolli*, rare in the earlier investigation, was not found in 1966.

NEMATODES

Only adult nematodes were examined from the summer of 1966. These showed a general reduction in frequency of occurrence from that of the earlier study, but no change in composition. *Dacnitoides cotylophora*, abundant in 1931, was the most common nematode, with *Philometra cylindracea* and *Spinitectus* sp. occurring occasionally.

COPEPODS

In addition to the helminths, parasitic copepods were frequently encountered on the gills of perch. These were identified as *Ergasilus caeruleus*. Copepod incidence was not reported in the previous study.

SEASONAL TRENDS

Seasonal fluctuations in intensity and incidence of parasites of yellow perch are known to occur (Tedla and Fernando, 1969). Despite the small sample size in this study, seasonal trends in occurrence of certain parasites of Oneida Lake perch were apparent. *Bunodera sacculata*, as noted by Van Cleave and Mueller, became common only after late August in 1969, although six incidences were found earlier

in the summer. Incidence of *Tetracotyle metacercariae* was greater and they occurred in larger numbers in August and September. *Bothriocephalus* sp. plerocercoids occurred most commonly from April to June, whereas adults were found in December. The common acanthocephalan, *Neoechinorhynchus cylindricus*, and the parasitic copepod, *Ergasilus caeruleus*, were practically absent from July and August samples. No seasonal trends were apparent in rate of infection by the common trematodes, *Crepidostomum cooperi* and *Diplostomum huronense*.

DISCUSSION

Although some of the differences in incidence of parasites probably resulted from differences in sampling emphasis, both areal and seasonal, the three previously unrecorded parasites, *Tetracotyle* sp., *Apophallus brevis* and *Urocleidus adspexitus*, would have been discovered had they been present 35 years earlier. Five times as many perch were examined by Van Cleave and Mueller (1934), and they specifically noted the absence of monogenetic trematodes and *Tetracotyle metacercariae* on perch. Their method of examination of the lateral musculature was duplicated for this study, so it is unlikely that they could have overlooked the *Apophallus metacercariae*. Therefore these parasites are considered to have become established as parasites of the yellow perch during the last 35 years.

It is not surprising that the most pronounced changes in parasitism were those involving the trematodes, most of which use mollusks as intermediate hosts, since significant changes in the mollusk population have occurred within the past 50 years in Oneida Lake. In particular, a population explosion by the gastropod *Bithynia tentaculata* has led to a reduction in abundance of other species of snails (Harman, 1968a), which could cause interruption of life cycles of digenetic trematodes with high host specificity.

Apophallus brevis is known to use the gastropod *Amnicola limosa* as an intermediate host. This snail was present in limited numbers at the time of the earlier study, but Sinclair (1969) found that local concentrations of *A. limosa* have developed in Oneida Lake since the earlier study and are probably responsible for the establishment of *A. brevis* since the parasite is specific to the yellow perch. In his survey of lakes containing *A. brevis*, Sinclair found that dense populations of *A. limosa* were necessary for a significant infection to occur.

Although *Tetracotyle metacercariae* occurred in Oneida Lake in 1931, they were probably different species from that found in this study, since they did not occur in the yellow perch at that time.

It is not likely that *Tetracotyle* has been introduced with the three new species of fish, i.e., gizzard shad (*Dorosoma cepedianum*), white perch (*Roccus americanus*) and freshwater drum (*Aplodinotus grunniens*), since it has not been reported from any of them (Hoffman, 1967). Unfortunately, studies of the life cycle and intermediate host specificity of the *Tetracotyle* metacercariae are incomplete, and the question of whether the appearance of this parasite in perch was the result of changes in the bottom fauna or of introduction of the parasite to Oneida Lake remains unresolved.

The increase in occurrence of *Crepidostomum cooperi*, if significant, is the opposite of that expected on the basis of bottom fauna changes. Studies of the life cycle of this trematode (Choquette, 1954) indicate that its metacercarial stages occur in the mayfly *Hexagenia*, which has virtually disappeared from Oneida Lake (Jacobsen, 1966). In addition, the cercarial and redial stages occur in sphaeriid clams, which apparently have declined in abundance since earlier in the century (Noble, 1969).

The absence of *Clinostomum marginatum* in the 1966 sample may be related to a decline in population of its first intermediate host (*Helisoma* sp.); however, these snails are not uncommon in Oneida Lake (Harman, 1968b). Since *C. marginatum* is most prevalent in shallow, protected waters (Van Cleave and Mueller, 1934), its absence may be related to the diminution of marshland around the fringe of Oneida Lake which has accompanied the development of the shoreline for summer cottages.

The monogenetic trematode *Urocleidus adspetus* was probably introduced since 1931, since the parasite requires no intermediate host and is specific to the yellow perch. Described from nearby Cross Lake, it has likely made its way into Oneida Lake via the New York State Barge Canal. Since the population of yellow perch in Oneida Lake is quite dense, the parasite should have had little difficulty becoming established after it gained access to the lake.

No pronounced loss of parasite species has occurred as would be expected as the result of a decrease in the diversity of bottom fauna. Rather, more or less random changes in incidence of parasitism have taken place. Evidently, although many species of benthic organisms have been suppressed, populations are still sufficient to effectively serve as intermediate hosts. Otherwise, intermediate host specificity is probably not very pronounced, and the mollusk population in general suffices to fulfill the capacity of intermediate host. Further studies on life cycles and host specificity would be needed for the impact of benthos changes to be better understood.

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EFFECTS OF POPULATION REMOVAL ON THE HABITAT OF SMALL MAMMALS

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ABSTRACT

Possible changes in distribution and habitat preference of small mammal species as a result of reduced population pressures was studied by intensively trapping a 0.996-hectare area on the eastern shore of Cranberry Lake (N. Y.) in the summer of 1967. The effect of population removal on habitat preference was not great. Regardless of the population density, distribution of the species was the same throughout the study period. Elimination of one species in a habitat did not result in the appearance of another species.

As the populations of a community increase in size, changes for social interaction increase. In an area inhabited by several species, those which interact more successfully may become socially dominant (Patric, 1958). The level of intolerance which one species demonstrates toward the others may be an important factor in determining the specific habitat of each. The socially dominant species may occupy much of the habitat of the subordinate species, or even force them into a less favorable habitat. Thus what appears to be the full extent of a subordinate's habitat might not be that under different circumstances.

Small mammal species can apparently occupy habitats less favorable than they normally prefer. Webb (1965), Manville (1950) and Beer *et al.* (1954) found meadow mice (*Microtus pennsylvanicus*), which normally inhabit meadows and grasslands, to be thriving on forested islands. Webb's study was conducted only 1.25 miles from the site of the present study.

The present study was designed to assess the habitat preferences of members of a small mammal community as the population density was reduced by removal trapping. If the more dominant species, which have a higher probability of capture, are caught and removed first, then the more subordinate species should occupy any additional and also preferred habitats vacated by the more dominant individuals. Even if capture probabilities for each species were equal, a redistribution of the individuals or an enlargement of habitat preference might occur due to the reduced population pressures.

¹ Derived from an M.S. thesis submitted to the Graduate School at the State University of New York at Albany. The author wishes to thank Dr. Margaret M. Stewart for her advice during the study and for reading the manuscript, and Dr. P. C. Lemon for his help. Appreciation is also extended for permission to carry out this study at the Cranberry Lake Biological Station.

METHODS AND MATERIALS

The study was conducted in the summer and fall of 1967 at the Cranberry Lake Biological Station of the State University of New York at Albany, in the Charles Lathrop Pack Demonstration Forest, 6 miles from the hamlet of Cranberry Lake in St. Lawrence County. The study area was three-fourths of a mile east of the station, bordering the northern shore of Sucker Brook. Mean elevation was 1,600 feet, ranging from 1,630 to just under 1,600. The site was a square 328 feet on a side encompassing 0.996 hectare.

It contained four habitat types: a plantation of conifers, an open hardwood forest, a zone of shrub growth and an open grassy meadow. Respectively, each type comprised approximately 40, 9, 19 and 31 per cent of the study site. The coniferous portion consisted of a uniform plantation of white spruce (*Picea glauca*), a native species, planted before 1929. The hardwood forest consisted primarily of yellow birch (*Betula lutea*) and red maple (*Acer rubrum*) all about 40 years old. The meadow had been created by an abandoned beaver dam and was covered by bluejoint (*Calamagrostis inexpansa*) arranged in close hummocks. Between the forested portions and the meadow was a shrub zone consisting of speckled alder (*Alnus rugosa*), meadowsweet (*Spiraea latifolia*) and several species of raspberry (*Rubus*) and arrowwood (*Viburnum*). Figure 1 shows the relative positions of the habitat types.

One hundred mouse-sized Victor snap traps were placed in a grid, roughly north-south and east-west, with an interval of 32.8 feet (as suggested by Vest, 1956). One trap, baited with peanut butter and rolled oats, was placed at each station. These were tended twice a day, at 6:00 a.m. and 6:00 p.m., from July 8 to August 9 for a total of 3,300 trap-nights. The area was retrapped on October 7 and 8. The species and trap location were recorded each time an animal was caught. Each time the traps were tended, the weather, water level and grass conditions were recorded. Maximum and minimum temperatures for each 24-hour period were recorded in the meadow and in the conifers.

The weather was cool, overcast and rainy; the grass was continually wet throughout the study period. Standing water covered some of the meadow for 58 per cent of the time. Temperatures ranged between 41° and 84° F. The meadow showed the greatest extremes.

RESULTS

The record of animals caught during July and August is given in Table 1. The deer mice (*Peromyscus maniculatus*) were caught in the wooded areas without any preference for cover type. The short-

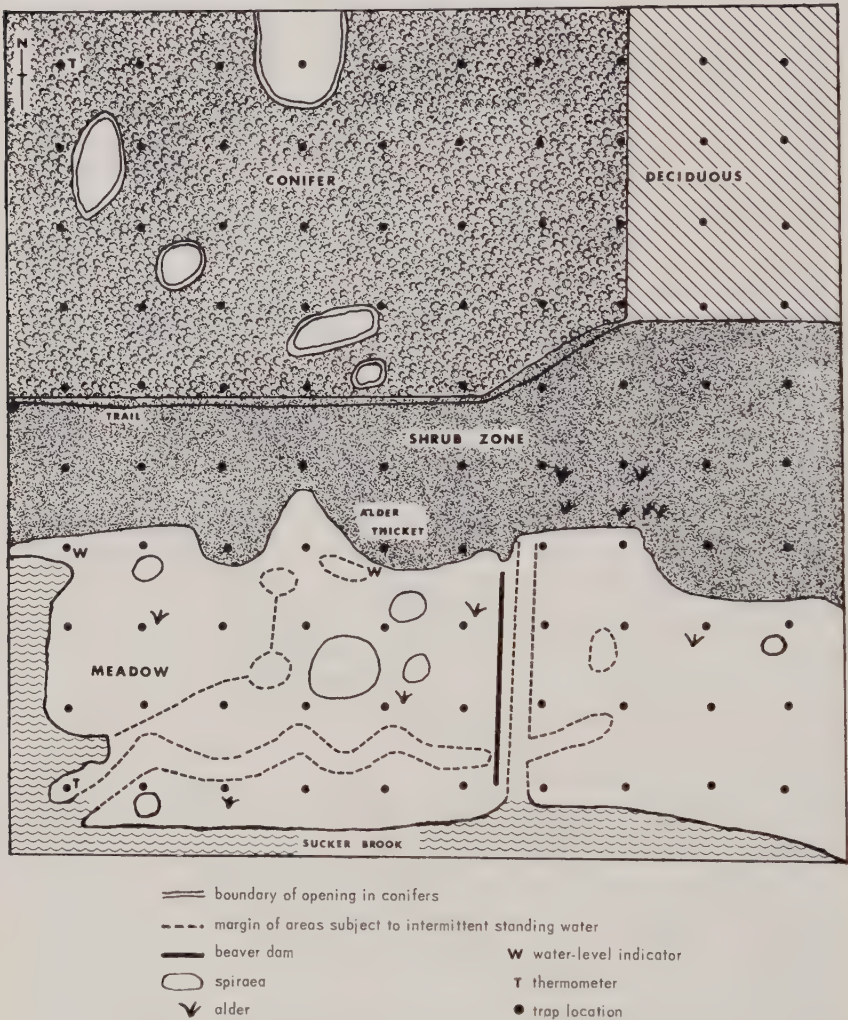


Figure 1. Map of study area showing the four vegetative types (i.e., coniferous, deciduous, shrub and meadow) and other features.

tailed shrews (*Blarina brevicauda*) were caught in all habitats but showed a preference for the wooded areas. The red-backed mice (*Clethrionomys gapperi*) were captured in the wooded areas. The masked shrews (*Sorex cinereus*) were captured in all habitat types. These shrews showed a marked preference for situations where alder was 100 per cent of the cover and if captured in the meadow, it was always under or near a shrub. The meadow mice (*Microtus pennsylvanicus*) and meadow jumping mice (*Zapus hudsonius*) were captured in the meadow. The woodland jumping mice (*Napaeozapus*

insignis) were captured in the conifers. The one chipmunk (*Tamias straitus*) was captured in the deciduous forest but must be considered an accidental due to the size of the animal relative to the size of the trap.

After July 28, no animals were caught until August 3, and it is assumed that all the resident individuals had been captured. The nine animals caught during the subsequent trap-nights (August 3 to 9)

TABLE 1. DAILY CATCH OF SMALL MAMMALS DURING JULY AND AUGUST IN 1967*

Date	Deer mouse	Short-tailed shrew	Red-backed mouse	Masked shrew	Meadow mouse	Woodland jumping mouse	Meadow jumping mouse	Chipmunk	Total
July 8	3n	1d, 2n	1n	..	2n	..	..	..	9
9	1n	4n	..	1d, 1n	1n	..	..	..	8
10	2n	..	..	1d, 1n	1d	..	..	..	5
11	1n	1n	..	5d, 3n	..	..	..	1d	11
12	1n	1d, 1n	..	..	..	..	..	..	3
13	2n	1n	..	2n	..	..	..	..	5
14	..	..	..	1d, 2n	..	..	..	..	3
15	1n	1n	..	1d, 2n	..	..	..	..	5
16	1n	1d, 1n	1n	1d, 4n	1d, 1n	..	..	..	11
17	..	1n	..	1d	..	..	..	..	2
18	..	..	..	..	..	1n	..	..	1
19	..	..	..	2n	..	..	..	..	2
20	2n	1n	..	1d	..	..	..	..	4
21	2n	..	..	..	..	..	..	..	2
22	..	1n	..	1n	..	1n	..	..	3
23	..	1d	..	..	..	..	..	..	1
24	1n	..	1n	..	..	..	..	..	2
25	..	..	..	1n	..	..	..	..	1
26	1n	..	..	..	..	..	..	..	1
27	..	1n	..	1n	..	..	..	..	2
28	1n	..	1n	1d, 1n	..	..	..	..	4
29	..	..	..	..	..	..	..	..	0
30	..	..	..	..	..	..	..	..	0
31	..	..	..	..	..	..	..	..	0
August 1	..	..	..	..	..	..	..	..	0
2	..	..	..	..	..	..	..	..	0
3	..	..	..	1d	..	..	..	..	1
4	..	..	..	1n	1n	..	..	..	2
5	..	..	..	1n	..	..	2n	..	3
6	..	..	..	1n	1n	..	..	..	2
7	..	..	..	..	..	..	..	..	0
8	..	..	..	1n	..	..	..	..	1
9	..	..	..	..	..	..	..	..	0
Total	19	19	4	39	8	2	2	1	94

* Letters following numerals: n = taken at night; d = taken during day.

were assumed to be immigrants since many were captured close to the border of the study area. Although there was probably an influx from outside the area during the initial 2,100 trap-nights, as had been observed elsewhere (Stickle, 1946; Patric, 1958), the rate of influx was probably greater after all residents had been removed because of the lack of competition.

Capture dates were plotted to detect changes in habitat preference as the trapping continued. However, the expected expansion of habitat did not occur. The habitats occupied did not change during the study. Furthermore, the diurnal and nocturnal habitats were identical, but there was a difference in the species and number caught during each period. Of the total catch, 79 per cent were collected during the night. Deer mice, red-backed mice, woodland jumping mice and meadow jumping mice were caught only at night, while short-tailed shrews, masked shrews and meadow mice were caught both day and night. Approximately 25 per cent of the short-tailed shrews and meadow mice were captured during the day. Also, 36 per cent of the masked shrews were captured during the day, showing it to be the most active diurnal species.

The study area was retrapped in the fall for 200 trap-nights (October 7-8) using the same methods as before. This yielded the same species in the same habitats as the July-August trapping. Nine animals were caught, all at night. One masked shrew was captured in the shrub zone, four red-backed mice and two deer mice in the conifers, and two meadow mice in the meadow.

DISCUSSION

Several aspects of these observations are of interest.

FACTORS DETERMINING HABITAT PREFERENCE

Masked shrews were caught in all parts of the study area, but showed a strong preference for alder and meadowsweet cover. Getz (1961a) and Connor (1960) also caught this shrew in various types of habitat. It was not inhibited by standing water, a characteristic also observed by Getz. Manville (1949) felt that moisture rather than vegetation type influenced its distribution.

Short-tailed shrews were captured in all parts of the study area except the meadow. Chew (1951) and Pruitt (1959) found that the distribution of this shrew was dependent on the moisture in its burrow. Chew stated that it could not regulate its evaporative water loss at low humidities, thus agreeing with Pruitt's findings that it is found in areas where soil moisture maintains a saturated condition in the burrows. Since the weather was generally cool, overcast and rainy

throughout the study period, there was little chance for the standing water to evaporate; hence the principle method of drying was runoff. Drainage was slow due to the flat terrain and because the water table was only a few inches below the surface when the meadow was dry. Perhaps the absence of the short-tailed shrew in the meadow was due to the poor burrowing conditions present, a relationship noted elsewhere by Connor (1960).

The deer mice preferred the cooler, more humid habitat of the conifers, hardwood forest and shrub zone rather than the less humid meadow habitat. Connor (1960) found this mouse most abundant in mature forests of all types, especially at this altitude. Klein (1960) and Brower and Cade (1966) found it near water in dense cover of all forest types.

As with the deer mouse, a high evaporative water loss compels the red-backed mouse to live in a cool moist habitat to prevent desiccation. It was taken only in wooded areas. Connor (1966) captured this species on the Tug Hill plateau (N. Y.) in all types of forest. Brower and Cade (1966) caught it primarily in coniferous forests and found its preference due to a high evaporative water loss.

Meadow mice were found only in the meadow. Their grass-covered surface furrows are more appropriate for the wet meadow environment than are the underground burrows of the short-tailed shrew, only one of which was caught in the meadow along the meadow-shrub border. The presence of this shrew, a predator, may be a reason meadow mice were confined to the meadow. Eadie (1944) and Patric (1962) suggested such a relationship.

The meadow jumping mouse was taken only in the wet meadow. Getz (1961b) found that vegetation type, temperature, cover and interspecific competition did not effect its distribution, but it was found only in wet meadows with standing water.

Brower and Cade (1966) found that the woodland jumping mouse preferred shrub cover near streams or standing water. Neither animal caught during the present study was in such a habitat, but the small number taken does not permit conclusions concerning habitat preference.

Some individuals of each species were caught at night; short-tailed shrews, masked shrews and meadow mice were caught also during the day. Most small mammals are thought to be nocturnal because of the protection from predation that darkness offers. The high metabolic rate of the shrews forces them into activity day and night. Pearson (1947) found that the masked shrew and short-tailed shrew have the highest and second highest metabolic rates of 13

small mammals tested. The grass-covered runways of the meadow mouse could account for this animal's diurnal activity by providing protection from predation.

FALL TRAPPING

The major difference noted in the follow-up fall trapping was that no short-tailed shrews were caught. This may be significant because this species comprised 21 per cent of the total summer catch. Rood (1958) found temperature to be an important factor in the short-tailed shrew's activity in captivity and that it is only active when it is warm enough. It may not have been warm enough for this shrew. Nor were jumping mice of either species caught at this time. They may have already entered winter hibernation or the summer trapping may have eliminated them from the area.

If trap lines are set in the same habitat and in the same manner, but in different seasons, it is possible to compare the populations of the different seasons. However, Patric (1958) suggested that such comparisons may be unrepresentative because bait preference, age ratios, food supplies, etc. may have changed during the time interval between the two trapping periods.

DAILY COMPOSITION OF CATCH

The composition of the daily catch remained about the same throughout the trapping period. There was no major change or trend except that the numbers decreased as time progressed with unexplainable random increases. Webb (1965) reported similar results. Patric (1958) stated that the red-backed mouse was represented initially in his trapping data, whereas the masked shrew was not represented until later because it was socially more subordinate; in other words the more aggressive species was taken first. Data from the present study, however, do not support his findings. He also found that when the short-tailed shrew population increased, the numbers of deer mice and red-backed mice decreased, and vice versa. Eadie (1948) stated that *Blarina* may be an important predator on small animals. Thus one would expect short-tailed shrews to be captured initially and eliminated first. In this study, all species were eliminated at about the same time. Thus no definitive dominant-subordinate relationship was found.

CONCLUSIONS

The data show that in the area studied the effect of population removal on small mammal habitat preference was not great. Regardless of the population density, distribution of the species was the same throughout the study period. Other features seemed to be

more important in habitat selection than the presence of other species. Elimination of one species in a habitat did not result in the appearance of another species; therefore the capture probability of each species was about equal. Subsequent trapping revealed that most of the same species were present after 2 months. The absence of some species could have been due to their inactivity.

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OBSERVATIONS ON NEWLY INTRODUCED LANDLOCKED ALEWIVES IN MAINE¹

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ABSTRACT

Three Maine lakes were stocked in 1966 with landlocked alewives taken from Cayuga Lake, New York. Two lakes supported alewives in 1969. Spawning activity apparently took place from about mid-June to mid-August. Growth of both transplanted alewives and their progeny was very rapid. Alewives occupied the mid- to upper water in summer and fall, but descended to deeper water in winter and spring. The food of alewives was almost entirely microcrustacea, although a few insects were eaten.

In recent years the landlocked alewife (*Alosa pseudoharengus*) has been studied extensively as forage for piscivorous game fish. As part of a general research program to improve the sport fisheries of the state, in particular that for landlocked salmon (*Salmo salar*), the Maine Department of Inland Fisheries and Game introduced landlocked alewives into three lakes. Spawning habits, growth rates, seasonal depth distribution and food habits of this species are reported here.

ORIGINAL DISTRIBUTION

Alewives were apparently originally limited to the Atlantic coast of North America and probably occurred only in the anadromous form (Threinen, 1958). However, introductions and altered waterways have extended their distribution into many freshwater lakes. Today there are many completely landlocked populations in the midwestern and eastern United States and in Canada, and additional introductions are planned in other areas. Lake Ontario, as well as Seneca, Cayuga and Keuka Lakes in New York, have supported landlocked alewives since the late nineteenth century. Lakes Erie, Huron, Michigan and Superior have all acquired populations since 1930 (Miller, 1957). Freshwater alewife populations were established, apparently by fishermen, in New Jersey in 1850 (Gross, 1953). Several small Connecticut lakes have long supported landlocked alewives, although the method of introduction is unknown (Brooks and Dodson, 1965).

INTRODUCTION INTO MAINE

In June 1966, about 3,000 adult landlocked alewives were transported by truck from Cayuga Lake, New York, and planted in three

¹Supported by the Maine Department of Inland Fisheries and Game. The New York State Conservation Department cooperated in making it possible to obtain alewives from Cayuga Lake.

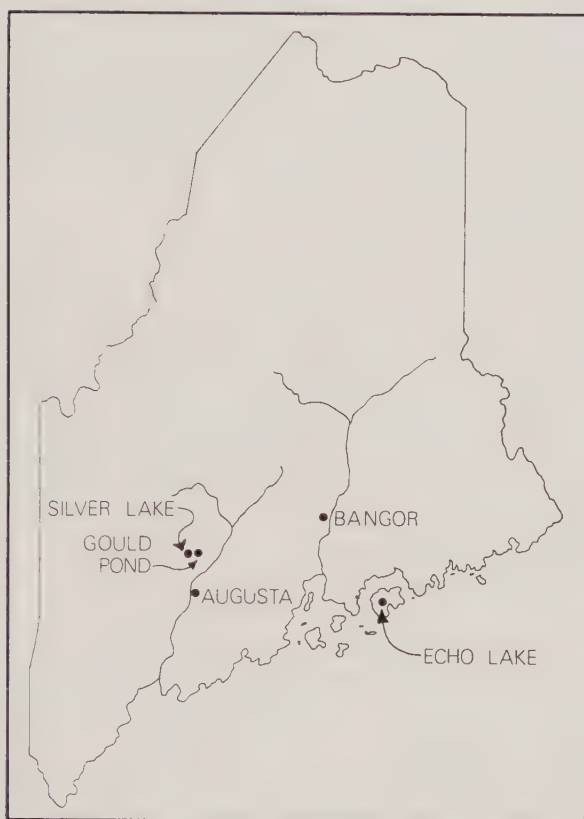


Figure 1. Map of Maine showing location of lakes used for experimental introduction of landlocked alewives.

Maine lakes. They were predominantly 2- or 3-year-old fish and ranged in total length from 130 to 150 millimeters. About 750 were released in Silver Lake (Figure Eight Pond) and 750 in Gould Pond of the Summer Haven Chain of ponds near Augusta (Figure 1). The remaining 1,500 were stocked in Echo Lake on Mount Desert Island.

Silver Lake covers 11.7 hectares with a maximum depth of 20 meters. Gould Pond covers 7.1 hectares with a maximum depth of 11 meters. Both are kettle-type ponds of glacial origin surrounded by gravel ridges. Inlets and outlets are absent except for a small overflow into Gould Pond from another small kettle-type pond during periods of heavy rainfall. Echo Lake is 94.8 hectares in area and 19 meters deep, of glacial origin and surrounded by mountains. Permanent inlet and outlet streams are present.

An alewife population had become well established at Silver Lake by 1969. Intensive netting in Gould Pond indicated that introduced alewives failed to reproduce or survive their first winter. Alewives in Echo Lake spawned successfully in the summer of introduction and subsequent summers. The population has increased enormously.

SPAWNING

Odell (1934) observed alewife spawning in Seneca Lake, New York, from late May to mid-August. Pritchard (1929) found alewife spawning in Lake Ontario to be somewhat variable, but most frequently in late May and early June. Landlocked alewives in Lake Hopatcong, New Jersey, spawned in late June (Gross, 1953, 1959). Rothschild (1966) observed alewives spawning in Cayuga Lake mainly in July. Anadromous alewives generally ascend rivers in May and June in Maine and enter lakes and ponds to spawn (Havey, 1961). A limited amount of spawning takes place in deadwater stretches of rivers and streams.

Alewife spawning activity in Silver Lake was observed in 1966, 1967, 1968 and 1969. Robert Foye (personal communication) observed surface thrashing by alewives in shallow water during several evenings from mid- to late June and early July of each year since introduction. Such activity was also noted by Rothschild (1966) for alewives in Cayuga Lake.

Alewife behavior that could be interpreted with certainty as spawning activity was not observed in Echo Lake. Ripe fish were taken from mid-June to mid-August in 1967. The majority of these

TABLE 1. GROWTH (TOTAL LENGTH IN MILLIMETERS) OF LANDLOCKED ALEWIVES IN ECHO LAKE COMPARED WITH THAT IN OTHER WATERS* AND WITH GROWTH OF ANADROMOUS ALEWIVES IN LONG POND§

Age	Maine		New York			Lake Michigan	Lake Ontario
	Echo Lake	Long Pond	Cayuga Lake	Seneca Lake	Kensico Reservoir		
0+	89	..	75	30	..	96	40
I+	114	135	102	68	55	139	77
II+	175	221	121	144	86	158	134
III+	..	274	130	151	98	173	156
IV+	..	310	138	168	113	..	161
V+	..	315	144	172	130	..	184

* Data derived as follows: Cayuga Lake (Rothschild, 1965); Seneca Lake (Odell, 1934); Kensico Reservoir (Breder and Nigrelli, 1936); Lake Michigan (Norden, 1967); Lake Ontario (Graham, 1956).

§ Back-calculated from older fish (Havey, 1961).

were fish introduced from Cayuga Lake, but several Echo Lake-hatched alewives appeared to be sexually mature when captured. This observation is interpreted as a strong indication that landlocked alewives will spawn as 2 year olds. Rothschild (1966) collected ripe 2 year olds in Cayuga Lake, and Gross (1953) felt that alewives in Lake Hopatcong, New Jersey, matured at 2 years. Ripe fish in Echo Lake were usually taken in shallow water (2-3 meters) over mud-rock bottom.

GROWTH

Monthly growth of alewives hatched in Echo Lake and growth rates of alewives inhabiting other lakes are given in Table 1.

To a large extent the exceptionally rapid growth of Echo Lake alewives can be attributed to the existence of a vacant or near-vacant niche within the fish fauna of the lake. The only pelagic plankton feeder in Echo Lake prior to introduction of alewives was the American smelt (*Osmerus mordax*). The smelt population was estimated to be quite small during the project period (Lackey, 1968a).

SEASONAL DEPTH DISTRIBUTION

Small-meshed vertical gill nets were designed and built to determine the depth distribution of landlocked alewives in Echo Lake (Lackey, 1968b). Additional data were gathered by setting horizontal gill nets at known depths.

By far the most abundant of the several year classes of alewives in Echo Lake when this study was started were fish hatched from adults introduced from Cayuga Lake. This first spawning in the new environment was highly successful, and it is not unlikely that 1966 year class alewives were more abundant in 1967-68 than those of the 1967 year class. Seasonal depth distribution of the 1966 year class at that time is presented in Figure 2.

The relatively shallow distribution (3 to 6 meters) of alewives from June to November and deeper distribution later indicate a definite trend. With the coming of winter, the alewives moved into the lake depths.

Although data were obtained on other alewife year classes, not enough information is available to make quantitative statements. The 1967 year class appeared to follow roughly the same distribution as that of the 1966 year class based on available captures. It is not known, however, where these fish were located immediately after hatching.

Galligan (1951, 1962) reported on the depth distribution of alewives in Cayuga Lake. Alewives exhibited a pronounced inshore

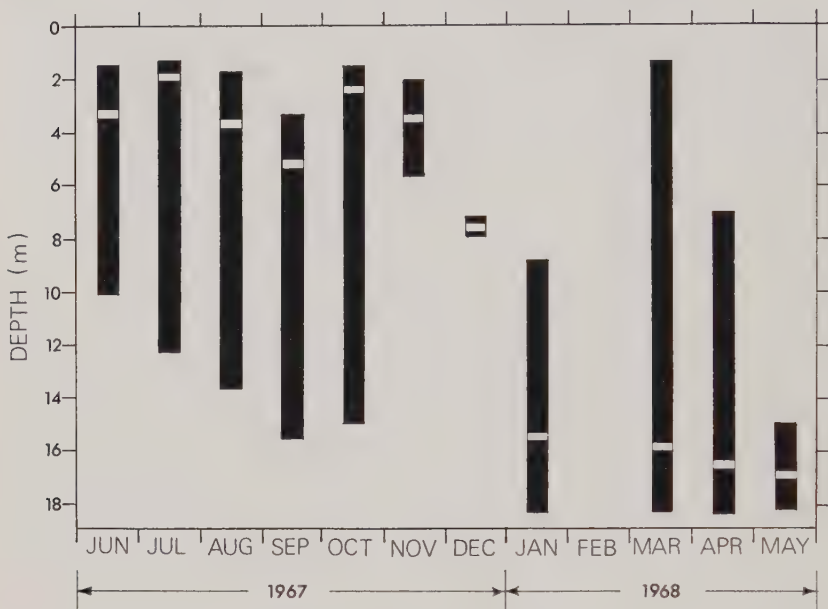


Figure 2. Seasonal depth distribution of landlocked alewives of 1966 year class in Echo Lake as determined from vertical and horizontal gill netting in 1967-68. Solid bars represent depth range; white area in each bar represents depth of highest concentration of fish.

movement in late June and July associated with the shallow-water spawning habits of the species. Galligan further reported that Cayuga Lake alewives moved to deeper water during late summer and fall. Breder and Nigrelli (1936) hypothesized that alewives take up a pelagic distribution in winter. Gross (1953, 1959) reported similar results for Lake Hopatcong in New Jersey.

The distribution of alewives in Echo Lake followed the general pattern reported by Galligan (1951, 1962), Gross (1953, 1959) and Breder and Nigrelli (1936), but differed in several respects. In summer and fall alewives in Echo Lake occupied the upper strata of the lake, mainly away from shore. With the onset of winter, there was a marked movement to the deeper waters where they remained until the following summer.

FOOD

Food habits of 1966 year class alewives are summarized in Figure 3. Analysis of stomach contents through careful estimation of volume for each item, expressed as a percentage of the total volume, proved to be of comparable accuracy to actual measurement by water displacement. The amount of material in even a full alewife stomach

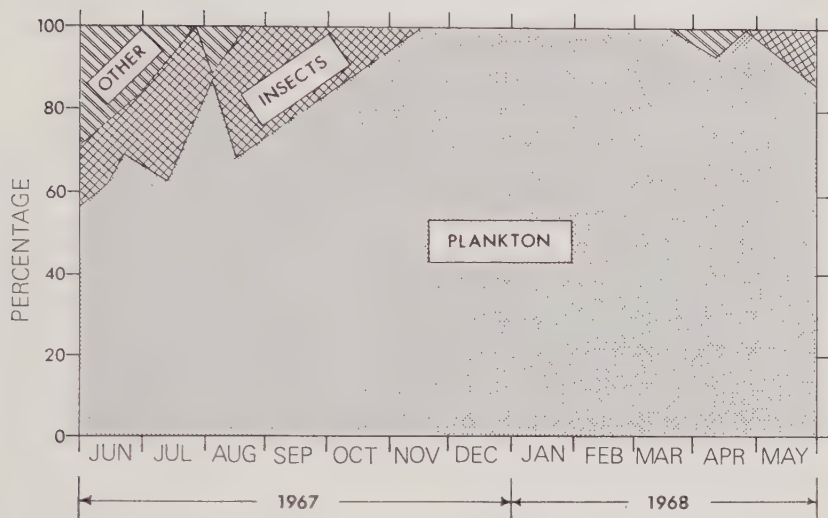


Figure 3. Seasonal food (by volume) of landlocked alewives of 1966 year class collected in Echo Lake in 1967-68.

was always very small, and a marked degree of homogeneity of diet during much of the year minimized errors associated with subjective evaluations (Lackey, 1969).

The diet of Echo Lake alewives agreed quite closely with that determined by other workers for other lakes. Hutchinson (1968) reported that alewives in Black Pond, a small pond in northern New York, fed extensively on dipteran larvae when available (mainly in September). Unfortunately, no data are available on fall, winter and spring feeding habits of alewives in Black Pond. Odell (1934) found microcrustacea to constitute 46 per cent of the alewife diet by volume in Seneca Lake, New York. Odell also found insects and alewife eggs making up a significant part of the diet in June and July. The diet of alewives in Lake Michigan has been found to be mainly copepods and amphipods (Morsell and Norden, 1968). Young-of-the-year anadromous alewives have been observed in Maine by Robert Foye (personal communication) in stomachs of mature adult anadromous alewives while still in freshwater.

However, the diet of alewives in Echo Lake differed in several respects. Utilization of dipteran larvae was similar to that reported by Hutchinson for Black Pond, but it was quite different from that reported by Morsell and Norden for Lake Michigan. This might be expected because of the greater availability of Diptera in a small lake. Morsell and Norden also found copepods and the amphipod, *Ponto-*

poreia affinis, the main food items, while midge larvae, ostracods and hydracarina formed minor parts of the diet.

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PREVENTING BIRD DAMAGE TO SPROUTING CORN WITH A CARBAMATE REPELLENT¹

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ABSTRACT

The effectiveness of DRC-736 [4-(methylthio)-3,5-xylyl *N*-methylcarbamate] as a seed treatment to reduce bird damage to sprouting corn was evaluated in April 1969 at the Three Rivers Wildlife Management Area in New York. One method of calculation showed that approximately 83 per cent fewer plants were destroyed by birds in treated fields, while a second method showed a damage reduction of about 71 per cent.

Birds damage sprouting grain in many areas of the United States. In some eastern states, corn damage caused primarily by common grackles (*Quiscalus quiscula*) has been so severe that some farmers have had to replant fields as many as three times.

The most practical means of reducing these losses appears to be chemical repellents applied as seed coatings before planting. The use of chemicals on crop and tree seeds to repel birds dates back almost 150 years, and most references through 1955 were well summarized by Neff and Meanley (1956). Coal tars, red lead and aniline dyes were repellents reported to be effective in reducing sprout pulling by pheasants (*Phasianus colchicus*) and crows (*Corvus brachyrhynchos*).

In later years, Klein (1957) recommended a thiram-lindane-gentian violet dye as a promising pheasant repellent in studies conducted in New York, and Young and Zevallos (1960) concluded that thiram, Drinox and DuPont Spreader Sticker were helpful as seed treatments to repel brown-headed cowbirds (*Molothrus ater*) and boat-tailed grackles (*Cassidix mexicanus*) from germinating maize in Mexico.

Apparently these methods have been available for decades, but some of them reduce or retard germination, or are ineffective. Presently, none is widely used, and farmers, on occasion, have resorted to the use of pesticides at "mis-use" concentrations in at-

¹ The authors wish to thank: Pearl Trumbull, manager of the Three Rivers Wildlife Management Area, for providing the test site and planting the treated seed; Alfred Godin, U. S. Bureau of Sport Fisheries and Wildlife, for assistance in evaluating the treatments; and Ralph Colson, George Elliot and Arthur Holweg, New York State Department of Environmental Conservation, for assistance in coordinating the study.

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tempts to protect their fields. This poses a threat to nontarget species of birds and justifies a continuing search for effective repellents.

Recently, West *et al.* (1969) showed that damage to sprouting corn by pheasants was reduced by more than 90 per cent by treating the seed with a new repellent, 4-(methylthio)-3,5-xylyl N-methylcarbamate or DRC-736.⁴ Of three concentrations (0.1 per cent, 0.5 per cent and 3.0 per cent) tested by these investigators, the 0.5 per cent treatment level was found to be the most economically effective. The 3.0 per cent concentration was reported to be twice as effective as the same treatment level of thiram, one of the most promising repellents recommended by earlier investigators. In Texas, West and Dunks (1969) showed that on corn seed the 0.5 per cent treatment level of DRC-736 afforded about 70 per cent protection from boat-tailed grackles.

In laboratory studies, Schafer and Brunton (1969) reported that DRC-736 was also highly repellent to common grackles and red-winged blackbirds (*Agelaius phoeniceus*) with median effective levels of 0.056 per cent and 0.089 per cent, respectively.

This paper reports the results of a field test conducted to determine the effectiveness of DRC-736 as a seed treatment to reduce bird damage to emerging corn.

On April 16, 1969, three adjacent cornfields were planted on the State-owned Three Rivers Wildlife Management Area near Baldwinsville, New York. Before planting, the seed for two fields (1.3 and 1.8 acres) was treated with a 0.5 per cent DRC-736-Kelzan water slurry. Kelzan⁵ is a synthetic colloidal additive that improves dispersion and acts as a sticker. The third field (0.8 acre) was planted with untreated seed and used as a control. The planting rate was one seed for every 6 inches of row in all fields.

Treatment effects were evaluated after 15 days, when most young plants were too large to be destroyed by birds. The total numbers of bird-damaged and undamaged plants were tallied in each of 15 0.016-acre plots (2 rows x 100 feet) randomly established in each field. Each plot should have contained 400 corn plants.

Approximately 83 per cent fewer plants were destroyed by birds in the treated fields than in the untreated field. The average percentage destroyed on plots in the control field was 32.9 and in the treated fields 8.8 and 2.4. An analysis of variance on data trans-

⁴ Also known as Bay 37344 and Mesurol. Courtesy Chemagro Corporation, Kansas City, Missouri. Reference to trade names does not imply endorsement of commercial products by the Federal Government or the New York State Department of Environmental Conservation.

⁵ Kelco Company, Los Angeles, California



Figure 1. Stands of mature corn about 4 months after planting: (below) treated with DRC-736; (above) control.

formed by the inverse sine transformation showed a significant difference in damage among treatments ($\alpha = 0.05$), and a subsequent Scheffe's S-test showed that bird damage was also significantly different ($\alpha = 0.10$) between the treated fields.

Altogether, the 15 plots in the control field lost 699 plants due to bird damage. Plots in the two treated fields lost an average of 205 plants (355 in one field and 75 in the other). This method of calculation shows a damage reduction of about 71 per cent.

Figure 1 illustrates the striking reduction in damage. There were 1,396 plants remaining in plots in the untreated field, and 3,713 and 3,296 in plots in the two treated fields, or about 2.5 times as many.

There were exceptionally large numbers of missing plants in all three fields. Some of these were probably due to low germination rate, as well as to heavy rains after planting which caused excessive moisture in low spots. However, it is strongly suspected that many of the missing plants resulted from early bird damage and simply could not be identified as such during the evaluation.

The authors were unable to explain the differences in damage between the treated fields because of the limited observations of bird pressure, which were made only from May 28 to June 1 and after most damage had occurred. During this time, more birds were present in the treated fields than in the control field. Of birds that damage sprouting corn, the greatest numbers noted at any one time were: 6 redwings and 1 grackle in the control field; 1 grackle, 15 redwings, 3 pheasants and 4 cowbirds in one treated field; and 14 redwings, 3 pheasants, 5 cowbirds and 1 crow in the other treated field. The extent of the damage caused by each species is not known, but it is likely that they all contributed. From the results of this test it appears that probably all species involved were effectively deterred from causing greater damage.

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GENERAL NOTES

CHANGES IN THE AQUATIC FLORA OF OTSEGO LAKE BETWEEN 1935-1969¹

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Intensive studies of Otsego Lake, the headwaters of the Susquehanna River, are being carried on at the Stephen C. Clark Biological Field Station at Coopers-town (N. Y.), a facility of the Biology Department of the New York State University College at Oneonta. As part of this work, the species of rooted aquatic plants present and their distributions in Otsego Lake were determined in the summer of 1969. In this paper, the findings are compared with data compiled in a similar study in 1935 by Muenscher (1936).

Muenscher gathered his specimens by hand picking while wading in the shallows and by using a plant hook in the deeper areas. In the present study samples were also taken by wading in shallow waters, but in deeper environments collections were made by using diving equipment. Taking specimens underwater made it possible to observe associations and obtain plants in locations where the use of plant hooks would have been practically impossible. The species and their relative abundance in each instance are shown in Table 1.

In 1935 Muenscher found emergent plants to be "very rare...except in the few small protected coves". In 1969 they were common except near the most exposed rocky shores. Beds of *Nuphar variegatum* and *Nymphaea odorata* were present in practically all embayments, while *Typha* spp., *Spartanium eurycarpum*, *Scirpus acutus* and *Eleocharis* spp. were encountered discontinuously along the protected shorelines.

In 1935 *Chara vulgaris* [includes *C. Contraria* (Wood and Muenscher, 1956)] dominated the substrates from 1 to 2 meters in depth. In many cases this macroscopic alga was accompanied by *Potamogeton gramineus*. *Chara vulgaris* was still prevalent in these localities in 1969, but *P. gramineus* was no longer an abundant plant. Many vascular plants, including *Najas flexilis*, *Heteranthera dubia*, *Elodea canadensis*, *Myriophyllum exalbescens*, *Potamogeton praelongus* and *P. Richardsonii*, that Muenscher recorded in up to 5 meters of water, were found mainly in the shallower areas in 1969. None of these plants formed dense beds, except for *H. Dubia* which covered extensive areas at the southern end of the lake.

Nitella flexilis was reported in water as deep as 7 meters in 1935 and was considered to have the deepest distribution of any macroscopic plant found in Otsego Lake. This characeous alga retained that distinction in 1969. Dense beds of *Potamogeton crispus* were almost always in association with *N. flexilis* and often appeared to supplant it. Not a native pondweed, this *Potamogeton* is of European origin and is often associated with polluted waters (Fassett, 1960). It was not found in Otsego Lake in 1935. With the exception of one bed of *P. pectinatus* at the northern end of the lake, *P. crispus* was the only *Potamogeton* that formed extensive beds with plants reaching the water's surface. In June and July an almost continuous strip of this plant followed the 5- to 7-meter contour completely around the lake. In late summer these beds collapsed and were no longer visible at the surface.

The beds of *P. crispus* occurred no deeper than 5 meters in the northern end of the lake, while at the southern end beds were commonly found at 7 meters.

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TABLE 1. COMPARATIVE OCCURENCE OF AQUATIC PLANTS IN OTSEGO LAKE IN 1935 AND 1969.

Species	Occurrence*	
	1935§	1969
<i>Typha angustifolia</i>	..	F
<i>Typha latifolia</i>	R	R
<i>Sparganium americanum</i>	R	..
<i>Sparganium eurycarpum</i>	A	A
<i>Potamogeton americanus</i>	F	..
<i>Potamogeton amplifolius</i>	F	R
<i>Potamogeton angustifolius</i>	F	..
<i>Potamogeton crispus</i>	..	A
<i>Potamogeton epihydrus</i>	R	..
<i>Potamogeton foliosus</i>	R	..
<i>Potamogeton Friesii</i>	C	..
<i>Potamogeton gramineus</i>	A	C
<i>Potamogeton illinoensis</i>	..	F
<i>Potamogeton natans</i>	F	R
<i>Potamogeton nodosus</i>	..	R
<i>Potamogeton panormitanus</i>	F	..
<i>Potamogeton pectinatus</i>	C	C
<i>Potamogeton praelongus</i>	C	F
<i>Potamogeton pusillus</i>	F	F
<i>Potamogeton Richardsonii</i>	C	F
<i>Potamogeton zosteriformis</i>	C	R
<i>Najas flexilis</i>	A	A
<i>Sagittaria latifolia</i>	F	R
<i>Elodea canadensis</i>	A	C
<i>Vallisneria americana</i>	C	C
<i>Zizania aquatica</i>	R	..
<i>Eleocharis acicularis</i>	F	..
<i>Eleocharis erythropoda</i>	..	C
<i>Eleocharis palustris</i>	R	R
<i>Dulichium arundinaceum</i>	R	..
<i>Scirpus acutus</i>	C	C
<i>Scirpus validus</i>	C	..
<i>Acorus calamus</i>	R	..
<i>Peltandra virginica</i>	R	..
<i>Lemna minor</i>	F	F
<i>Spirodela polyrhiza</i>	F	F
<i>Heteranthera dubia</i>	A	A
<i>Pontederia cordata</i>	R	..
<i>Polygonum amphibium</i>	R	R
<i>Ceratophyllum demersum</i>	A	F
<i>Brasenia Schreberi</i>	R	..
<i>Nymphaea odorata</i>	F	C
<i>Nuphar variegatum</i>	F	C
<i>Ranunculus aquatilis</i>	C	F
<i>Ranunculus reptans</i>	R	..
<i>Nasturtium officinale</i>	..	R
<i>Ludwigia palustris</i>	F	R
<i>Lythrum salicaria</i>	..	R
<i>Myriophyllum exalbesens</i>	C	F
<i>Utricularia vulgaris</i>	F	..
<i>Megalodonta beekii</i>	C	F
<i>Equisetum limosum</i>	R	..
<i>Equisetum arvense</i>	..	R
<i>Chara vulgaris</i>	A	A
<i>Nitella flexilis</i>	A	C
Total number	47	35

* R = rare; F = frequent; C = common; A = abundant.

§ As recorded by Muenscher (1936).

All other species showed somewhat similar but shallower distributions. It was noted that the transparency of the water at the northern end of the lake was consistently much less than that at the southern end. This increased turbidity was due to siltation rather than planktonic algae. Materials were kept in suspension by molar action on the silty shallows along the northern shores. It is probable that the resultant decrease in transmitted light affected the depth at which the compensation plant occurred for most species (the depth where oxygen utilization equals photosynthesis) and was reflected in the maximum depths at which various plants were able to exist.

In summary, emergent plants had become more plentiful in Otsego Lake by 1969 than they were in 1935. Many submergent plants occupied shallower waters than they had earlier. Species diversity had decreased somewhat, and a recently introduced species (*P. crispus*), often found in enriched environments, had become a dominant member of the flora. These phenomena indicate an increase in eutrophication over the 34-year interval that, unfortunately, is to be expected in bodies of water in highly populated areas such as central New York State.

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QUICK FREEZING AS A STANDARD METHOD
FOR EYE LENS COLLECTION¹

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Environmental temperature is an uncontrollable variable encountered during field collection of eye lenses. Temperatures are often low enough to cause freezing of lenses collected or so high as to allow considerable autolysis before fixation can be accomplished. The use of very low temperature as an initial collection procedure is a standard method that can be applied to all field situations; an application of this method is described.

Slow freezing, such as that which may occur under field conditions, has been shown to cause reductions in raccoon (*Procyon lotor*) and cottontail rabbit (*Sylvilagus floridanus*) lens weights (Montgomery, 1963; Pelton, 1970). Pelton (1970) concluded that the magnitude and variability of differences between unfrozen and frozen cottontail lenses was so great that frozen lenses were of little value for determining age. However, changes in lens weights among laboratory rats and guinea pigs subjected to various temperature extremes resulted from decomposition and mechanical damage due to alternate freezing and thawing rather than from freezing alone (Friend, 1967). Longhurst (1964), using domestic sheep, also failed to observe any significant changes in lens weights due to freezing alone.

In the present study, both eyes were removed from white-tailed deer (*Odocoileus virginianus*) killed by hunters during a special postseason hunt in January 1966. One eye was placed in 10 per cent formaldehyde following standard fixation procedures, and the remaining eye was placed in a dry ice chest and allowed to freeze. Identification of eyes was maintained by attaching a spring-clip laundry tag with the identification number of the specimen to the optic nerve. The frozen eye was removed from the chest the following day and placed in a container of 10 per cent formaldehyde in which fixation was allowed to take place as the eye thawed. After 14 days in formaldehyde the lenses were removed from the eyes, oven dried at 120° C. for 7 days, cooled for 15 minutes at room temperature and then weighed to the nearest 0.1 milligram on a Mettler (Model B) single-pan analytical balance.

The mean difference for the 52 pairs of deer lenses tested was 3.1 milligrams. This difference was found to be highly significant when a paired *t*-test was used to analyze the data ($t = 5.9$, 51 df). In nearly all cases (44 of 52), the frozen and then formaldehyde-fixed lenses were heavier than those subjected only to formaldehyde fixation. The means of the two groups were 417.5 milligrams for the former and 414.4 milligrams for the standard formaldehyde fixation group. Differences between lenses varied from 0.2 to 11.5 milligrams, and lens weights ranged from approximately 300 to 575 milligrams.

These data support the hypothesis that freezing at very low temperatures can be used as a standard method for field collection of eye lenses (Friend, 1968). The differences observed between lenses in most instances did not exceed that expected between lenses from the same animal. The greater weight of the majority of lenses subjected to freezing may reflect reduced autolysis and hence reduced losses of fluids and cellular materials from the lens (Friend, 1967).

The conditions of this study, like those of Longhurst (1964), guarded against decomposition and involved a single period of freezing prior to fixing, drying and weighing the lenses. Lenses collected from animals in freeze lockers or from uncontrolled conditions in the field where freezing takes place due to environmental temperatures may be expected to exhibit the types of variation observed by Montgomery (1963) and Pelton (1970). These differences are due to decomposition and tissue damage from slow, and possibly multiple, periods of freezing and thawing.

The reasons for fixing lenses in formaldehyde have been previously stated (Friend, 1968), and it was also noted that the actual fixation reaction between

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proteins and formaldehyde is very slow. It was recommended that fixation be carried out at low temperatures (0° - 5° C.) to minimize autolysis. Quick freezing followed by thawing in formaldehyde meets these objectives and is recommended as a standard method for field collection. Two methods for quick freezing have been suggested in an earlier publication (Friend, 1968).

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DDT RESIDUES IN EGGS OF MARSH-INHABITING BIRDS¹

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Since 1965, there has been a gradual decline in the number of nests of the clapper rail (*Rallus longirostris*) in several marshes along the south shore of Long Island, New York (Robert Johnson, personal communication). Residues of DDT and its metabolites (DDD and DDE) have been thought to cause bird mortality for a variety of reasons (Hickey, 1969; Stickel and Stickel, 1969). Therefore, it was felt that DDT residue analyses on rail eggs might give an indication of its role in this decline. While collecting the rail eggs, eggs from nests of the black-crowned night heron (*Nycticorax nycticorax hoactli*) and the marsh hawk (*Circus hudsonius*) were also collected. All the eggs were from abandoned nests in 1969. A few of the clapper rail eggs contained embryos, but the rest showed no signs of development. The areas where collections were made are indicated in Figure 1.

Four eggs were collected from each of four clapper rail nests, while two night heron eggs from the same nest and one marsh hawk egg were also collected. The eggs from each nest were considered a separate sample. Each sample was mixed with a drying agent, sodium sulfate and QUSO (9:1), until the eggs were completely homogenized. The homogenate was extracted with petroleum ether for 4 hours, and the extractant was sent through a florisil column (Mills *et al.*, 1963) for cleanup. The analysis was done using a gas chromatograph equipped with an electron capture detector.

The results are given in Table 1. For the rail eggs, the values were rather consistent between the various areas sampled and much lower than those for the marsh hawk and night heron. The values for the marsh hawk and night heron



Figure 1. Map of Long Island showing areas where eggs were collected: (A) Hempstead Bay, (B) South Oyster Bay, (C) Captree Island.

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TABLE 1. DDT RESIDUES FOUND IN EGGS OF MARSH-INHABITING BIRDS ON LONG ISLAND, NEW YORK, 1969*

Species	Location	Date collected	DDT residue in mg/kg			
			DDE	DDD	DDT	Total
Clapper rail	Captree Island	August 1	0.096	0.115	0.150	0.361
	Hempstead Bay	August 7	0.111	0.157	0.135	0.403
	Hempstead Bay	August 8	0.103	0.138	0.135	0.376
	South Oyster Bay	August 8	0.101	0.119	0.151	0.371
Marsh hawk	Hempstead Bay	September 9	16.9	3.93	4.57	25.40
Black-crowned night heron	South Oyster Bay	December 5	15.6	1.24	1.58	18.42

* For number of eggs in each case, see text.

compared well with data from nearby marshes reported by Woodwell *et al.* who found 13.8 mg/kg of DDT residues in one osprey egg (*Pandion haliaetus*) and 7.13 mg/kg in five eggs of the common tern (*Sterna hirundo*). The higher values for the marsh hawk and night heron eggs, as well as those reported by Woodwell, probably reflect the birds' feeding habits. Ospreys, terns, marsh hawks and herons prey on organisms which are one step higher in the food chain than the rails' prey. Fish are the main food for the osprey, tern and heron, and rodents and birds for the marsh hawk, while the rail feeds primarily on fiddler crabs (*Uca* sp.) and snails (*Melampus bidenatus*). It is well known that DDT is concentrated as it passes through the food chain.

Anderson *et al.* (1969) considered DDE to be the main environmental pollutant causing birds to produce thin-shelled eggs. For eggs of the double-breasted cormorant (*Phalacrocorax auritus*), they found an inverse correlation between shell thickness and DDE residues. The shell thickness decreased from 0.40 to 0.35 millimeter as the DDE concentrations in the eggs rose from about 7 to 27 mg/kg. Although no evidence of thin-shelled eggs was detected in the present study, the values obtained for the marsh hawk and night heron eggs were sufficiently high to cause concern. It should be noted that the heron eggs were abandoned at least 5 months before collection and were subject to intensive microbial action during this time.

Values for the clapper rail were low compared with those for other birds that are thought to be declining because of DDT residues in their eggs. Ames (1966) found 3.0 mg/kg in eggs of a stable osprey colony in Maryland and 5.1 mg/kg in eggs of a declining colony in Connecticut. Excessive reproduction failure occurred in a herring gull (*Larus argentatus*) colony in Wisconsin due to shell-flaking and embryo mortality. DDE residues in nine eggs sampled amounted to 202 mg/kg. These data suggest that perhaps other causes are responsible for the decrease in the numbers of clapper rails in Long Island marshes. During the nesting season, many people visit these marshes for recreational purposes. It is known that several species of birds will abandon their nests if disturbed too often.

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SMALL MAMMAL POPULATIONS IN CUT AND UNCUT
NORTHERN HARDWOOD FORESTS¹

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The Adirondack Mountain region of northern New York is heavily forested. Commercial clearcut logging (removing all merchantable hardwood trees over 14 inches dbh and all merchantable softwood trees over 12 inches dbh) is one kind of land management that has pronounced effects on some species of wildlife (Krull, 1963). The following comments depict the relative abundance of several species of small mammals following this kind of forest treatment. Observations were made on portions of two 1,000-acre areas, one cut and the other uncut, on the Huntington Forest, a 15,000-acre property of the State University of New York, College of Forestry, located mostly in Essex County near the village of Newcomb. The characteristics of the two areas were described by Krull (1970). Both herbaceous and woody ground cover were much more abundant and diverse on the cut area throughout the period of study.

Data on the relative abundance of small mammals on the two areas were gathered each year from 1953 to 1962. The snap-trapping system used was a minor modification of the standard trapping procedure formulated for the North American census of small mammals (Calhoun, 1948). Intensive trapping, using peanut butter as bait, was carried out on both areas for four successive nights during the first part of July when small mammal populations are known to be high. A permanent grid was used and in each area either 150, 240 or 300 traps were located at 50, 80 or 100 stations. Therefore, the number of trap-nights varied from 600 to 960 to 1,200, depending upon the year. In any given year the number of trap-nights was the same in each area. All trapping was done in the northern hardwood forest type (S.A.F. Type No. 25).

The numbers caught are summarized in Table 1. Data for long-tailed shrews (*Sorex* spp.), meadow mice (*Microtus pennsylvanicus*) and southern bog lemmings (*Synaptomys cooperi*) are included in the total column, but are not presented individually because population levels were very low. Only 38 long-tailed shrews (23 on the cut area and 15 on the uncut area), 3 meadow mice (1 and 2), and 2 southern bog lemmings (1 and 1) were caught.

More red-backed mice (*Clethrionomys gapperi*) were caught on the uncut area than on the cut area in nine of the 10 years. In the other year the number was identical, but this was a low-catch year when only three individuals were taken on each area.

More white-footed mice (*Peromyscus* spp.) were captured on the uncut area than on the cut area during the first nine years, while in 1962 no individuals were taken on either area. Harris (1968) reported that these mice were six times more plentiful in uncut areas as compared with cut areas in coniferous forests of Alaska, while Tevis (1956) found that logging caused an increase in their numbers in western Douglas fir forests.

For the short-tailed shrew (*Blarina brevicauda*), abundance was somewhat greater on the cut area for six years, it was somewhat greater on the uncut area for two years, and it was the same for two years. The years of equal abundance, however, were years of low or no catch.

For the woodland jumping mouse (*Napaeozapus insignis*), abundance was greater on the cut area for four years; it was considerably greater during two of these years. During five years abundance was greater on the uncut area, and in one year a zero catch was recorded.

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TABLE 1. NUMBER OF SMALL MAMMALS CAUGHT ON THE TWO STUDY AREAS, 1953-1962

Year*	Area	Red-backed mouse		White-footed mouse		Short-tailed shrew		Woodland jumping mouse		Total§	
		Number caught		Number caught		Number caught		Number caught		Number caught	
		Total	Per 100 trap-nights	Total	Per 100 trap-nights	Total	Per 100 trap-nights	Total	Per 100 trap-nights	Total	Per 100 trap-nights
1953	Uncut	116	9.66	23	1.92	7	0.58	5	0.40	152	12.66
	Cut	108	9.00	20	1.66	12	1.00	0	0.00	143	11.90
1954	Uncut	57	4.76	91	7.58	18	1.50	0	0.00	168	14.00
	Cut	25	2.08	21	1.76	5	0.40	2	0.16	54	4.50
1955	Uncut	4	0.32	7	0.58	7	0.58	0	0.00	21	1.74
	Cut	3	0.24	3	0.24	5	0.40	0	0.00	12	1.00
1956	Uncut	4	0.66	10	1.66	5	0.82	3	0.50	25	4.16
	Cut	0	0.00	1	0.16	10	1.66	1	0.16	12	2.00
1957	Uncut	3	0.50	18	3.00	5	0.82	1	0.16	27	4.50
	Cut	3	0.50	13	2.16	8	1.32	0	0.00	26	4.32
1958	Uncut	16	1.66	4	0.41	0	0.00	1	0.10	22	2.29
	Cut	9	0.93	0	0.00	0	0.00	4	0.41	14	1.45
1959	Uncut	138	14.37	31	3.22	44	4.58	10	1.04	225	23.43
	Cut	72	7.50	29	3.02	50	5.20	32	3.33	188	19.58
1960	Uncut	11	1.14	26	2.70	4	0.41	6	0.62	53	5.52
	Cut	4	0.41	6	0.62	4	0.41	1	0.10	21	2.18
1961	Uncut	40	4.16	77	8.02	32	3.33	0	0.00	149	15.52
	Cut	34	3.54	61	6.35	35	3.64	31	3.22	166	17.29
1962	Uncut	1	0.10	0	0.00	0	0.00	4	0.41	5	0.52
	Cut	0	0.00	0	0.00	1	0.10	1	0.10	3	0.31
Total	Uncut	390		287		122		30		847	
	Cut	258		154		130		72		639	
Average	Uncut	39.0	3.77	28.7	2.91	12.2	1.26	3.0	0.32	84.7	8.43
	Cut	25.8	2.42	15.4	1.60	13.0	1.41	7.2	0.75	63.9	6.45

* Number of trap-nights in each area: 1,200 from 1953 to 1955; 600 in 1956 and 1957; 960 from 1958 to 1962.

§ Includes data for long-tailed shrews, meadow mice and southern bog lemmings (see text).

Considering all seven genera that were trapped during the 10-year period, 847 animals were caught on the uncut area, while 639 were caught on the cut area. Populations of red-backed mice and white-footed mice were generally higher on the uncut area, while short-tailed shrew and woodland jumping mouse populations were generally higher on the cut area. For the first three species, however, there was no significant difference (employing a *t*-test to compare 10-year means) at the 1 per cent level between mean mouse populations on the two areas. Woodland jumping mice, on the other hand, were significantly higher on the cut area. If a generalization can be made without regard to species, it can be concluded that commercial clearcut logging had a minor effect on small mammal populations.

The data indicate that there were annual changes in population density. These changes seemed to have occurred irrespective of the effects of earlier habitat manipulation. Red-backed mice, the most common small mammal on both areas, had years of peak abundance in 1953 and 1959, suggesting a periodicity of six years. Relatively low populations occurred between these peak years, with reproduction being more successful at this time than during years of high populations (Patric, 1962).

Population fluctuations of white-footed mice were more irregular. Population highs were evident in 1954 and 1961, with lesser peaks in 1957 and 1959. This may indicate that a peak population in this genus can be expected every two to three years.

A cyclic trend is difficult to recognize for either the short-tailed shrew or woodland jumping mouse. Yearly increase and decrease seems to be the rule.

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POLYDACTYLISM IN A WHITE-TAILED DEER FROM NEW YORK¹

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In February 1970 at the Seneca Army Depot in Seneca County, New York, a 2½-year-old female white-tailed deer (*Odocoileus virginianus*) was shot which had a polydactylous right front limb (Figure 1). At autopsy, it had no other gross abnormality and was in good flesh with a dressed weight of 87 pounds. Two fetuses, a male and a female, found in the uterus did not exhibit the polydactylous condition.

The supernumary (extra) structure consisted of two digits, i.e., a hoof and a "dew claw", and a freely movable extra metacarpal could be felt along the lateral line of the cannon bone. No interdigital gland was formed for the extra hoof.

On dissection and cleaning, the polydactylous limb (Figure 2) was found to have an extra, slightly bowed, metacarpal 144 millimeters long and 9 millimeters wide in the central part. This metacarpal was loosely attached, by cartilage, to the lateral tuberosity of the cannon bone. The major digit was made up of three



Figure 1. Polydactylous right foot of female white-tailed deer from Seneca County, New York.

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Figure 2. Lateral view of the dissected polydactylous right foreleg.

phalanges, and the hoof had a lower surface length of 73 millimeters and an upper surface length of 50 millimeters. The minor digit, or dew claw, had a lower surface length of 26 millimeters and an upper surface length of 22 millimeters. The proximal sesamoids were present, but the small metacarpal was absent from association with the minor digit. Except for its smaller size and the absence of the small metacarpal and interdigital gland, the supernumary structure appeared to represent half the normal anatomy of the right foreleg of the deer as described by Blankenship *et al.* (1969).

Only one case of polydactylism has been previously reported in North American cervids, a female white-tailed deer fawn from eastern Ontario, Canada (Miller and Cawley, 1970). The normal front foot in this species has four digits. The Ontario specimen had five digits, and the one from Seneca County had six.

Both the Ontario and Seneca County deer had polydactylism of the right foreleg, and reports of polydactylism in deer from other parts of the world have all involved the front legs (Miller and Cawley, 1970). Perhaps this is due to genetic factors, but it does not seem probable for the Seneca County deer, unless a recent mutation took place. The Seneca Army Depot was established in 1942 and comprises 9,832 acres surrounded by a 7-foot fence and including about 7,500 acres of deer habitat. Since that time the deer population has been relatively isolated (Hesselton *et al.*, 1965). This population has been studied intensively by Conservation Department personnel, and no other case of polydactylism was encountered in the examination of more than 5,000 adult deer and 2,000 embryos. Therefore, it appears that deer have a predisposition for embryonic duplication of the tissues of the front limb buds.

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MICROPTHALMIA IN A WHITE-TAILED DEER¹*Ward B. Stone*Associate Wildlife Pathologist
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A blind white-tailed deer (*Odocoileus virginianus*) that had been kept captive since being found as a fawn (in Putnam County, New York) died while being transported to the Delmar Wildlife Research Laboratory in August 1969. The 1-year, 5-month-old spike-horn buck weighed 137 pounds (in the round) and had small eyes with opaque corneas. During transportation it had suffered multiple contusions and a brain hemorrhage that was the primary cause of death. Upon autopsy, the internal organs appeared grossly normal with the exception of the heart, which had an interventricular septal defect.

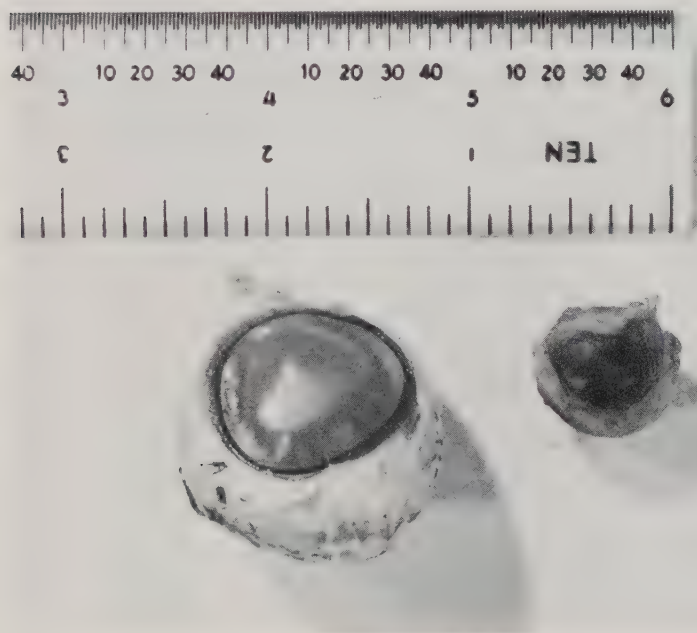


Figure 1. The small eye from the microphthalmic buck compared with an eye from a normal buck of the same age group and approximate body weight.

¹ A contribution of Federal Aid in Fish and Wildlife Restoration Projects W-35-R and W-89-R. The authors wish to thank Nicholas Drahos for the photography and Dr. John G. Debbie for examining the heart.



Figure 2. Comparison of the skull of the microphthalmic deer (lower) with that of a normal buck of the same age group and approximate body weight.

The eyes were removed and examined, and the skull was cleaned for study. Figure 1 compares the eyes of a normal buck of the same age and weight with those of the microphthalmic deer. The microphthalmic deer had opaque, thickened corneas, and small, irregularly-shaped, opaque lenses.

The skull showed gross abnormalities (Figure 2). The bony rim about the orbit of the eye was largely lacking, and the frontal region was narrow making the skull appear more laterally compressed than the usual deer skull. The high nasal bones gave it a "Roman nose" appearance.

Congenital microphthalmia has been observed in rats and swine (Smith and Jones, 1966), and congenitally blind, anophthalmic and opaque corneas have been found in white-tailed deer fawns (Dahlberg and Guettinger, 1956).

A blind deer would never reach maturity except in captivity (as happened in this case). The microphthalmia, modified bone structure and heart defect are believed to be a hereditary deficiency.

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A TEMPORARY BARRIER FOR USE IN SHALLOW STREAMS¹*Howard A. Loeb*Associate Aquatic Biologist
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It is often necessary, in stream management, to prevent or intercept the migration of fish. A large number of structures have been designed and tested for this purpose, most of them complicated, expensive and of at least a semi-permanent nature. The devices include rotary and stationary screens, electric weirs, inclined-plane traps, wing traps and weirs, barrier and jumping falls, and two-way traps. They serve the purpose of blocking migrations, capturing fish or diverting fish runs. Most of the structures are large, difficult to install and in need of frequent checks against power failure or to prevent debris accumulation.

Occasionally, a more temporary barrier can be used to prevent migration or to retain or capture dead and living fish during electro-fishing or chemical sampling and reclamation. Usually seines are stretched across the upper and lower limits of an area to prevent fish movement; these as often as not are not fish-proof and frequently collapse under the weight of rising water caused by accumulation of dead fish and debris. Kinsey and Holman (1955) designed and operated a simple, inexpensive, temporary trap to retrieve fingerling salmon that had been confined in receding stream pools during the summer. A dirt barrier only a few inches high guided water and fish into a 4-inch pipe leading to a box trap a few feet downstream.

A barrier employing identical principals has been designed and tested at flows of up to 20 cubic feet per second. It is practical for use in streams of any width provided the original water depth at the barrier site is not more than a foot or two. Briefly, it consists of burlap-covered A-frames through which culverts carry the flow to screen boxes a few feet downstream. Downstream migrants or dead fish are caught and upstream migration is prevented. A schematic side view of the device (Figure 1) shows the relationships among the few simple trap parts.

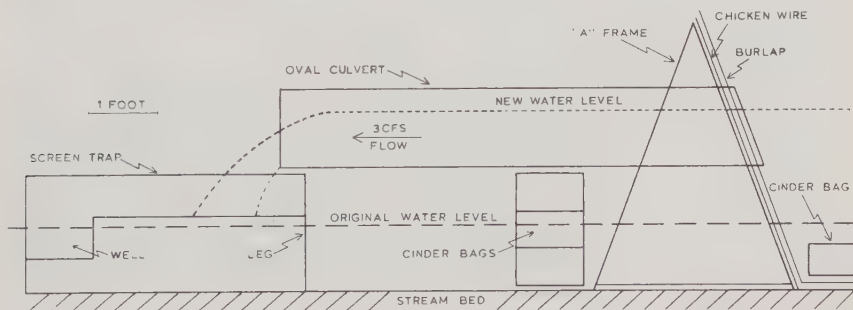


Figure 1. Schematic side view of A-frame, culvert barrier and trap.

The A-frames, which form the basic unit of the barrier, are constructed in lengths ranging from 2 to 10 feet and in heights and widths of 4 and 3 feet. They are made from braided lengths of $\frac{3}{4}$ -inch diameter, thin-walled electrical conduit. Each frame is covered on the upstream side with chicken wire and ultimately with burlap.

¹ A contribution of Federal Aid in Fish and Wildlife Restoration Project F-9-R.

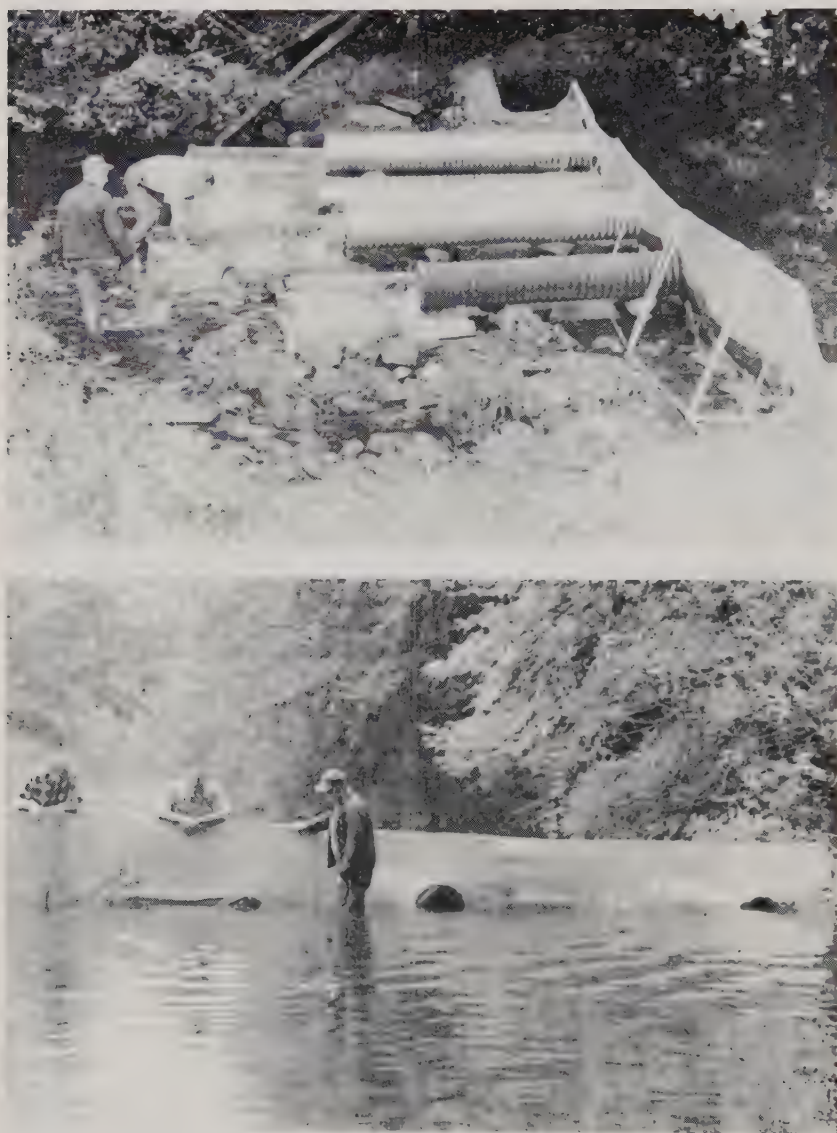


Figure 2. Downstream view of barrier (above) showing covered A-frames, culverts and screen traps; and upstream view (below) showing burlap facing and upper sections of culvert openings into which pool is flowing.

The frames are placed end-to-end across the stream on a fairly level, prepared site from which the rubble has been removed. Fish traps, 4 by 3 feet by 8 inches in depth and containing a shallow well, are placed several feet below the A-frames with the wells submerged. The traps are walled with window screening backed by hardware cloth. Levelled aluminum culverts are placed on cinder

bags and extend from openings cut in the chicken wire to the upstream edges of the traps. The culverts, originally 18 inches in diameter are pressed to a height of 14 inches and a width of 22 inches or are constructed in triangular form.

The ends of the barrier are extended onto the banks of the stream by walls of cinder bags. The final step involves facing the upstream sides of both the A-frames and cinder bag walls with a 6-foot-wide strip of burlap with the lower edge extending upstream on the stream bottom. The burlap is slit where necessary to allow the water to flow through the culverts into the traps. The bottom edge is pressed against the stream bottom with rocks, cinder bags or lengths of chain to provide a fish-tight seal. The construction is illustrated in Figure 2.

The apparent hydraulics of the barrier are fairly simple. Essentially the water flow is dammed by the burlap and flows through the culverts into the traps. Both the top edges of the traps and the bottom edges of the culverts must be elevated above the original water level to facilitate capture of fish. The stream flow which can be handled by the barrier is limited by the number of culverts, each of which can carry at least 4 cubic feet per second. The barrier is wedged firmly against the bottom by the rising pool above it, the ultimate height of which is regulated by the height of the culverts. The length of the pool decreases as the gradient of the stream increases. On a gradient, the traps are lower in relation to the A-frames and as a result the level of the culverts can also be lowered.

Debris accumulation is not a great problem. Water flow through the burlap is slowly prevented by clogging. Debris and fish are swept into the trap corners and wells thus allowing continued flow of water through the sides and bottom.

Materials required for a 50-foot-wide stream with a flow of 20 to 30 cubic feet per second can be hauled in a stake-bed truck. Construction can be completed by three men in a long day. Permanency is dependent on lasting qualities of the burlap, a matter of 2 to 3 weeks in 70° F. water. Cost is relatively low since all materials but the burlap and cinder bags are reusable.

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DETERMINATION OF CHLORINE DEMAND¹

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Chlorine demand in a given water is the amount of chlorine, in terms of parts per million, deactivated in 10 minutes by the organic material present; almost all of the deactivation takes place within that period. Determination of chlorine demand is necessary whenever chlorine or potassium permanganate is used to neutralize emulsified rotenone; enough neutralizer must be introduced both to detoxify the rotenone and to satisfy the chlorine demand. Since equal weights of chlorine and potassium permanganate have almost equal oxidizing capacity, the same factor applies to both. Thus, if 3 ppm of potassium permanganate were needed to neutralize 1 ppm of emulsified rotenone, and the chlorine demand was 1.5 ppm, the total amount of neutralizer required would be 4.5 ppm.

For use in stream reclamation work, the method described here is superior to the field method described by the American Public Health Association (1965) in that the apparatus is less cumbersome and both the standardization of the chlorine solution and the determination itself may be performed more rapidly. The kit used includes a 1-milliliter pipet graduated to tenths, three 100-milliliter beakers, a 100-milliliter graduate, a stirring rod, a medicine bottle each of orthotolidine solution and 1,000-ppm chlorine solution and a colorimeter (chlorine 0.1-4.0 ppm) with comparator cells².

The chlorine solution is prepared from a solution of sodium hypochlorite (household bleach) as follows:

1. Determine the concentration (C, expressed in grams per liter) of available chlorine in the bleach solution, using a Solvay bleach testing kit³ and following the directions attached to the kit.
2. Using a pipet, place 100/c milliliters of the bleach solution in a 100-milliliter volumetric flask.
3. Fill the flask to the line with distilled water and empty into a beaker to mix. Then fill the medicine bottle.
4. As a check on the concentration, add 0.1 milliliter of the solution to 100 milliliters of distilled water. Fill three comparator cells to the line, and add 1 dropper of orthotolidine solution to one of them. Let stand for 5 minutes. The residual chlorine reading should be 1 ppm.

To measure the chlorine demand of a water the following steps are taken.

1. Add 100 milliliters of a sample of the water to each of three beakers.
2. Using a pipet, add 0.1 milliliter of the 1,000-ppm chlorine solution to one beaker, 0.2 milliliter to the second, 0.3 milliliter to the third. Initial chlorine concentrations are then 1.0, 2.0 and 3.0 ppm, respectively.
3. Let the beakers stand for 10 minutes.
4. Remove the comparator cells from the colorimeter. Fill two with water from one of the beakers, and place in slots on either side of the outer slot, for color blanks.
5. Fill the remaining three cells to the line with water from each of the three beakers, respectively. Add one dropper (filled to the line) of orthotolidine solution to each cell.
6. Let stand for 5 minutes.
7. Read the residual chlorine values in the colorimeter. The chlorine demand equals the initial chlorine concentration minus the residual chlorine.

¹ A contribution of Federal Aid in Fish and Wildlife Restoration Project F-9-R.

² W. A. Taylor and Company, Baltimore, Maryland.

³ Solvay Process Division, Allied Chemical Corporation, Technical Service, Syracuse, New York.

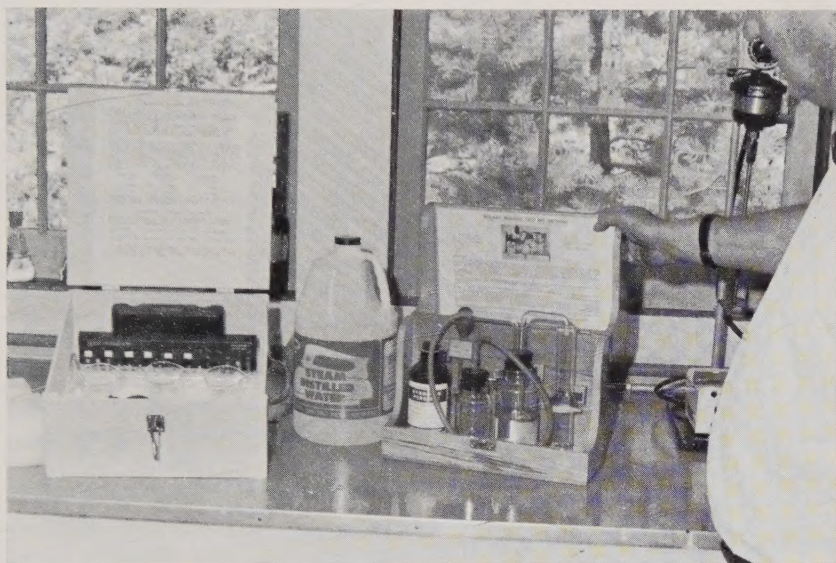


Figure 1. Solvay bleach-testing kit (right) and chlorine analysis kit.

In water samples having low chlorine demands, the readings obtained from the three chlorine concentrations should be consistent with each other. If the chlorine demand is high (over 1 ppm), it will be noticed that the residual chlorine in depleted samples will read slightly above zero (usually about 0.1 ppm) and that the apparent chlorine demand will increase slightly with increased initial chlorine concentration. In such a case, use the lowest concentration giving a residual value of 0.2 ppm or above. For example, for the following data,

<u>Initial chlorine</u>	<u>Residual chlorine</u>	<u>Difference (chlorine demand)</u>
1 ppm	0.1 ppm	0.9 ppm
2 ppm	0.5 ppm	1.5 ppm
3 ppm	1.3 ppm	1.7 ppm

the chlorine demand would be recorded as 1.5 ppm. If it appeared to be greater than 3 ppm, the test should be repeated adding 0.4, 0.5 and 0.6 milliliter of chlorine solution to 100-milliliter samples of water, etc.

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